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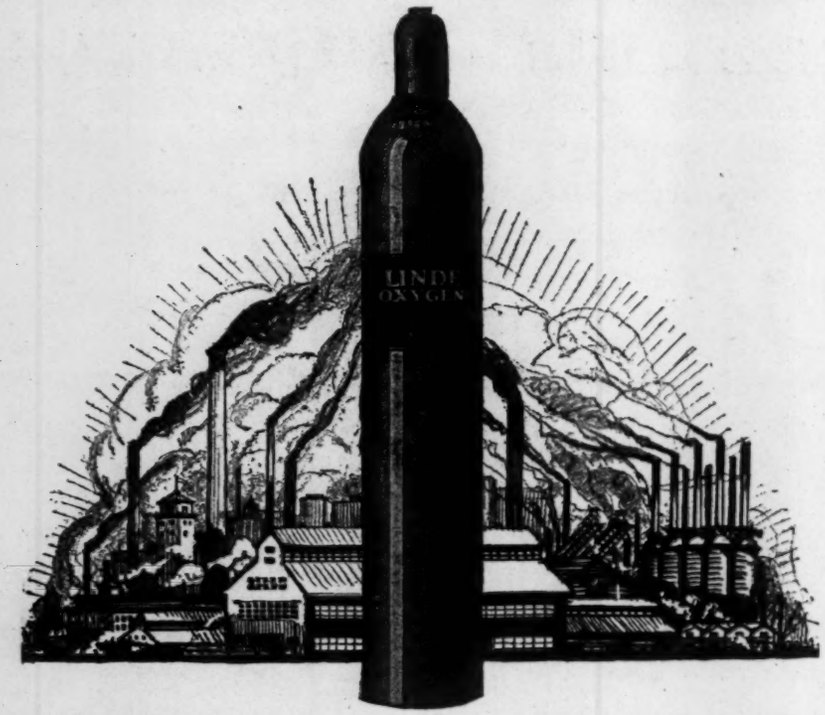
Three Papers on Burning Bituminous Coal on Stokers

JUNE 1922

THE MONTHLY JOURNAL PUBLISHED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS



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Contributors and Contributions

The Muscle Shoals Plant and the Nitrogen Supply

The fixation of atmospheric nitrogen and the chief features of the three best known methods are touched upon by J. K. Clement in his paper in this issue. Major Clement is well qualified to speak on certain phases of the Muscle Shoals Development. He was stationed at Nitrate Plant No. 2, Muscle Shoals, Ala., from September, 1918 until November, 1921, first as Assistant Director of Operations and later as Commanding Officer.

Major Clement received his B.S. from Trinity College and later a Ph.D. at Göttingen. Prior to his entrance into the army at the beginning of the world war, he had been engaged in physical and chemical research. From 1904 to 1907 he was employed as assistant in the Geophysical Laboratory, Carnegie Institute of Washington. From 1907 to 1910 he was employed as assistant physicist and physicist of the Technologic Branch of the U. S. Geological Survey and during the year 1908 was stationed at the Engineering Experiment Station of the University of Illinois. From 1910 until 1916 he was physicist of the U. S. Bureau of Mines, Experimental Station, Pittsburgh. He was engaged in investigations relating chiefly to explosions in mines and to the utilization of coal.

Some Principles of the Construction of Unfired Pressure Vessels

S. W. Miller, who presents a paper on forge welding and riveting, and the factors affecting welding efficiency, is the author of Oxy-Acetylene Welding published by the Industrial Press and of numerous other articles on the same subject. Upon leaving Stevens Institute in 1887, Mr. Miller became a machinist apprentice in the Logansport Shops. Between that time and 1910 he had a varied experience in a number of shops as master mechanic and shop engineer, in the design and installation of power plants and the supervision of plants building locomotives and automobiles. He made many experiments in oxy-acetylene welding in the various positions he held and in 1910 went to the Rochester Welding Works, of which he is now proprietor, and started oxy-acetylene welding there. In addition, he is employed as Welding Engineer in the research laboratory of the Union Carbide and Carbon Co., Long Island City.

Using Exhaust Energy in Reciprocating Engines

The theoretical problems of losses in reciprocating engines and practical applications to certain types of engines are discussed in this issue in a paper by Prof. J. Stumpf, with C. C. Trump collaborating. Prof. Stumpf was born in 1862 in Germany. He was graduated from the Technical High School, Aix la Chapelle, in 1888, after which he engaged in engineering work in Germany for a number of years. In 1893 he came to the United States and did work in mechanical engineering for Fraser and Chalmers in Chicago. He became a member of The American Society of Mechanical Engineers in 1896. Later he returned to Germany where he was Privy Councilor and Professor at the Technsche Hochschule, Charlottenburg and Kurfurstendamm. One of Professor Stumpf's contributions to science is the Stumpf Una-Flow Engine.

C. C. Trump, who collaborated with Prof. Stumpf in the paper in this issue, has been connected with both the Humphreys Gas Pump Co. and its subsidiary, the Stumpf Una-Flow Engine Co. of Syracuse, N. Y. He has received degrees from both Harvard and Cornell. He has done research, design and development work on various kinds of engines and helped to organize the Stumpf Una-Flow Engine Co. after returning from the experimental plant of Siemens-Schuckertwerkein Berlin. During the war he was a member of the U. S. Fuel Administration of New York State.

Weaving Machinery

L. B. Jenckes, whose paper on Weaving Machinery appears in this issue, was a director of the Crompton and Knowles Loom Works in Worcester, Mass., until his death on March 29, 1922. He received the degree of Ph.B. from Yale University in 1887, and was connected with the Westinghouse Electric Manufacturing Co. of Pittsburgh for a number of years. For 17 years preceding his death he devoted much of his time to the invention and perfection of many types of looms, on which subject he was an authority.

Management Applied to Textile Plants

As President and Manager of the Exposition Mills, Atlanta, Ga., George S. Harris is well fitted to speak with assurance on the subject of the organization and management of a cotton plant. Mr. Harris was educated at the Georgia School of Technology, the U. S. Naval Academy at Annapolis, and the Lowell Textile School, Lowell, Mass. After serving an apprenticeship for several years in the cotton mills of Northern Georgia, he became superintendent of the Sycamore Mills in Alabama. Following this he was superintendent of the Gate City Mills at Atlanta for two years. In 1907 he went to the Lanett Cotton Mills, West Point, Ga., where he remained until he was elected to his present position, in 1920. During his superintendency, the Lanett Mills were expanded from 60,000 spindles to 83,000 spindles, and a modern saw-tooth weave shed was erected.

Burning Bituminous Coal on Stokers

A group of three papers on Burning Bituminous Coal on Stokers appears in this issue. The two papers dealing with Taylor Stokers were written by O. J. Richmond, chief engineer of the power station of the United Illuminating Co., Bridgeport, Conn., and C. E. Wood who is connected with the Lunkenheimer Co. of Cincinnati, Ohio. R. A. Sanders, whose paper deals with Type E Stokers, is connected with the Seamless Rubber Co. at New Haven, Conn.

A.S.M.E. SPRING MEETING

As we went to press, we received word of the remarkable success of the Spring Meeting at Atlanta and a brief account is included in this issue, page 403.

An account of the social and entertainment features appears in the A.S.M.E. News for May 22. The July issue of MECHANICAL ENGINEERING will carry a statement of the technical features of the meeting.

MECHANICAL ENGINEERING

Volume 44 June, 1922 Number 6

The Muscle Shoals Plant and the Nitrogen Supply[1]

A Résumé of the Development of the Nitrate Industry in the United States and a Discussion of Its Present Requirements

By J. K. CLEMENT,[2] WASHINGTON, D. C.

This paper opens with an outline of the essential uses of nitrogen in this country and goes on to cover briefly the four forms in which nitrogen was obtainable before the processes for taking it from the atmosphere were developed.

The fixation of atmosphere nitrogen is taken up, the chief features of the three best-known methods being touched on.

Development of the industry in the United States leads to a discussion of the Government Nitrate Plant No. 2 usually spoken of as Muscle Shoals. The general conditions of this plant are outlined, including its power and raw-material requirements and the convenience with which these requirements can be supplied.

The various chemical processes are explained in some detail and finally some charts and a table give interesting side lights on the nitrogen situation in this country and abroad.

THE enormous consumption of nitrogen in the production of ammunition during the war emphasized its importance in the manufacture of military explosives. Nitrogen is an essential constituent of practically all explosives, both military and those used in blasting, mining and other industrial purposes.

Quite recently the publicity concerning the Government's projects at Muscle Shoals has recalled attention to the importance of nitrogen in agriculture and industry.

Nitrogen is essential to all vegetable and animal life and is required in a number of important industries; for example, the dye and drug industry, the refrigeration industry, the manufacture of artificial leather, photographic films, acids and chemicals. Of the three important elements of commercial fertilizers, nitrogen, potash and phosphorus, nitrogen is probably the most important.

Sources of Nitrogen

Nitrogen is usually obtained in one of the following forms: proteins, ammonia, nitrates and cyanides.

The nitrogen contained in plants and animals is usually in the form of proteins and is known as organic nitrogen. A very considerable part of the nitrogen used in agriculture is organic nitrogen and is obtained from manure, cottonseed meal, dried blood, and tankage and fish scrap. Ammonia, nitrate and cyanide nitrogen are referred to as inorganic nitrogen. Until a few years ago the inorganic nitrogen supply of the world was obtained from the beds of sodium nitrate of Chile and from coal. With the exception of a small quantity of potassium nitrate produced in India, all of the "nitrate" nitrogen of the world came from Chile and the world was dependent on this source for its nitrogen for the production of explosives, nitric acid, and for use in certain important industries.

Ammonia and cyanides are obtained as by-products in the destructive distillation of coal in gas works and by-product coke ovens and in the distillation of shales.

Fixation of Atmospheric Nitrogen

Four-fifths of the air is nitrogen. The nitrogen of the air is, however, extremely inert, and this tremendous source of supply was therefore until within the past twenty years not available for use by man.

There are now three processes for the fixation of atmospheric nitrogen that are commercially successful:

a Arc process,
b Cyanamide process,
c Synthetic or Haber process.

Arc Process. The arc process was the first process successfully developed on a commercial scale. At the high temperature of the electric arc the oxygen and the nitrogen of the air combine to form nitric oxide. On cooling, the nitric oxide is further oxidized to nitrogen dioxide and absorbed in water to form nitric acid or acted upon by lime to form calcium nitrate. The arc process is the only fixation process that produces nitric acid directly. Its heavy power requirements, 8.41 kw-years per metric ton of nitrogen fixed, limit its use to localities where power is abundant and cheap. It has been developed chiefly in Norway.

Cyanamide Process. The cyanamide process is based on the fact that calcium carbide heated to about 1000 deg. cent. combines with nitrogen gas to form calcium cyanamide. Commercial cyanamide or lime nitrogen contains about 20 per cent nitrogen. It may be used directly as a fertilizer or treated with steam under pressure to form ammonia. The cyanamide process requires a large amount of power, 1.97 to 2.30 kw-years per metric ton of nitrogen. It was established in Italy in 1906 and later in Germany, Norway, Sweden, Canada, Austria-Hungary, France, Japan and Switzerland.

Haber Process. The Haber process for the synthesis of ammonia was established in Germany in 1913. Prior to the end of the world war it had not been successfully operated in any other country. A mixture of nitrogen and hydrogen gas, under a pressure of from 100 to 200 atmospheres, is passed over a suitable catalyzer heated to 550 deg. cent. A small percentage of the gases is converted into ammonia which is removed from the system, the remaining nitrogen and hydrogen being returned to the catalyzer. The power requirements are small, 0.42 kw-year per metric ton of nitrogen fixed.

Nitrogen-Fixation Plants in the United States

The desirability of the United States becoming self-sustaining as regards fixed nitrogen was recognized prior to our entry into the war, Congress having appropriated $20,000,000 for the investigation of nitrogen fixation and for the construction of nitrate plants in 1916. Shortly after the declaration of war the decision was made to erect a plant of small capacity, 10,000 tons of ammonia per year, using a modified form of the Haber process. Construction of this plant, United States Nitrate Plant No. 1, began in October, 1917.

The heavy losses to shipping caused by the German submarines in 1917 and 1918 threatened to reduce the tonnage available for the transportation of nitrate from Chile, and made it unsafe for the United States to depend on imported nitrates. To meet this condition a contract for the erection of United States Nitrate Plant No. 2 was made in November, 1917. This plant was to have a capacity of 110,000 tons of ammonium nitrate per year, and was to use the cyanamide process. The important consideration in the selection of the cyanamide process was its dependability. A plant using this process had been in operation for

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[1] Published by permission of the Chief of Ordnance, U. S. Army.

[2] Major, Ordnance Department, U. S. A.

Paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. Slightly abridged. All papers are subject to revision.

several years at Niagara Falls, Canada, and the services of the members of its operating organization were available for the design and operation of the Muscle Shoals plant. Later the program was increased to include United States Nitrate Plants Nos. 3 and 4 at Toledo and Cincinnati, Ohio, these plants to have a capacity of 55,000 tons of ammonium nitrate each.

The last two plants were not completed. Plant No. 1 was operated experimentally for several months, but not successfully. Plant No. 2 began operations about two weeks before the armistice was signed and was continued in operation long enough to demonstrate its ability to operate satisfactorily.

United States Nitrate Plant No. 2

United States Nitrate Plant No. 2 is located in northwestern Alabama, on the south side of the Tennessee River, about one mile below the Muscle Shoals. It is the largest cyanamide plant in the world, having a capacity of 220,000 tons of cyanamide or 110,000 tons of ammonium nitrate per year.

Construction of the plant began in January, 1918, and operation in October, 1918. The total cost including the 60,000-kw. steam power plant at Muscle Shoals, but not including the 30,000-kw. steam power plant on the Warrior River, the Warrior-Muscle Shoals transmission line and the Waco limestone quarry, was approximately $70,000,000.

The principal raw materials required, other than the nitrogen of the air, are limestone and coke. The daily consumption of these materials when operating at full capacity is 1200 tons of limestone and 300 tons of coke. An ample supply of limestone of pure quality is located about 30 miles south of Muscle Shoals. Coke can be procured at Birmingham.

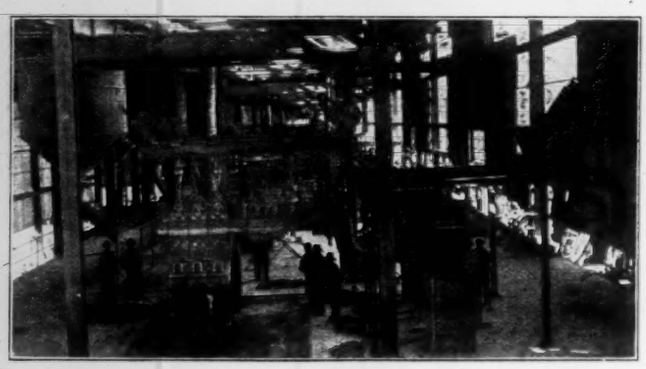

Fig. 1 General View of Carbide Furnaces Charging Floor

When operating at full capacity the plant requires approximately 85,000 kw. This power will eventually be available at Wilson Dam which is located within a mile of the nitrate plant. To furnish the power during the war and prior to the completion of the hydroelectric development on the Tennessee River, two steam power plants were erected: one at Muscle Shoals, and one at Gorgas on the Warrior River. The plant at Gorgas, known as the Warrior extension power plant, was built as an extension to the existing plant of the Alabama Power Company. The generating unit is a 30,000-kw. General Electric turbo-generator. The Muscle Shoals plant contains a 60,000-kw. Westinghouse turbo-generator consisting of one high-pressure and two low-pressure turbines each connected to a 20,000-kw. generator.

The limestone is burned in seven rotary kilns—one of which is a spare unit—each having a capacity of 200 tons of stone a day. The coke is crushed and dried and the lime and coke are mixed in suitable proportions for charging into the carbide furnaces.

The carbide furnaces are twelve in number—ten being required for full-capacity operation. Each furnace has a rated capacity of 50 tons of 80 per cent calcium carbide per day. The power consumption of one furnace is 6000 kw. The current is 3-phase, 60 cycles, and enters the furnace from the top, through carbon electrodes.

At the temperature of the electric arc, the lime and coke react to form carbide in accordance with the equation:

$$3C + CaO = CaC_2 + CO$$

The process is continuous, the molten carbide being tapped from the surface at intervals of about forty minutes. The carbon monoxide gas burns on contact with the air to carbon dioxide which escapes into the atmosphere. Fig. 1 gives a view of the furnaces.

The carbide is allowed to cool and is then ground to a fine powder. From the mill it is conveyed to the lime-nitrogen or cyanamide building where the fixation of nitrogen takes place. At a temperature of about 1000 deg. cent. calcium carbide and nitrogen react in accordance with the equation:

$$CaC_2 + N_2 = CaCN_2 + C$$

For this reaction a pure quality of nitrogen is desired. The nitrogen is separated from the oxygen of the air by the Claude process. The nitrogen or liquid-air building contains 30 Claude columns, each having a capacity of 500 cu. m. of nitrogen an hour.

The electric ovens in which the fixation of nitrogen takes place consist of vertical cylinders about 30 in. inside diameter and 5 ft. high. The heating unit is a carbon pencil located in the center of the oven. There are 1536 of these ovens. The weight of a charge of carbide is about 1600 lb. Nitrogen gas enters at the bottom of the oven. After about four hours the electric current is turned off and the reaction, being exothermic, proceeds without further external heating. The process requires about forty hours for completion. The product is removed from the furnace in the form of a cylindrical pig of cyanamide or lime nitrogen. After cooling, the pigs are crushed and ground to a fine powder. In this condition the lime nitrogen contains about one per cent of calcium carbide which is removed by spraying with water, the water reacting with the carbide to form acetylene gas which escapes. Fig. 2 illustrates these ovens.

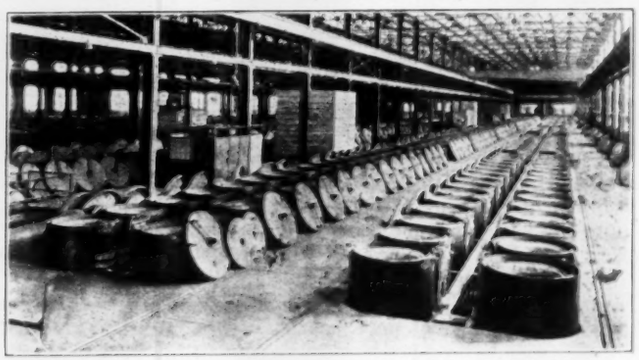

Fig. 2 Lime-Nitrogen Ovens

Calcium cyanamide reacts with steam under high pressure to form ammonia. The reaction is as follows:

$$CaCN_2 + 3H_2O = 2NH_3 + CaCO_3$$

This reaction takes place in large heavily walled steel autoclaves. The process is intermittent and requires from six to eight hours. The ammonia gas passes out at the top of the autoclave and carries with it a large amount of steam. Most of the steam is removed from the gas by condensation. The calcium carbonate is discharged in the form of a sludge and is a waste product. The plant has a capacity of 150 tons of ammonia per day.

The production of nitric acid from ammonia had never been carried out on a commercial scale prior to the world war, although the Ostwald process for the oxidation of ammonia to nitric oxide had been tried out on a small scale. If a mixture of ammonia and air is heated to a temperature of, say, 1000 deg. cent. under ordinary conditions, the reaction products obtained are nitrogen and water vapor. Ostwald found that by passing the gas over a suitable catalyzer, such as a fine platinum gauze, heated to a bright red heat, most of the nitrogen in the ammonia may be oxidized to nitric oxide:

$$2NH_3 + 2\tfrac{1}{2}O_2 = 2NO + 3H_2O$$

On cooling, the nitric oxide combines with more oxygen to form

nitrogen dioxide, which is then absorbed in water to form nitric acid.

In the Muscle Shoals plant the oxidation takes place in aluminum boxes or converters in the bottom of which the electrically heated platinum gauze is held in a horizontal position (See Fig. 3). The mixture of ammonia and air is passed downward over the gauze and the products of the reaction are carried to coolers and then to the nitric acid absorption towers. The capacity of the plant is about 450 tons of 50 per cent acid per day.

Ammonia and nitric acid react readily to form ammonium nitrate in accordance with the equation:

$$NH_3 + HNO_3 = NH_4NO_3$$

This reaction takes place in tanks lined with acid-proof brick, the ammonia gas being piped into the tanks from above. The product is a liquor containing about 45 per cent ammonium nitrate. This liquor after being freed from sediment is piped to the nitrate houses where the water is evaporated and the ammonium nitrate is finally obtained in granular form. It is then ready to be loaded in cars and shipped to powder plants.

During the time the plant was in operation about 1700 tons of high-grade ammonium nitrate were produced.

THE PRODUCTS AND THEIR UTILIZATION

During the war ammonium nitrate was used chiefly in the manufacture of amatol, a mixture of ammonium nitrate and trinitrotoluene in the proportion of 80 parts ammonium nitrate to 20 parts TNT.

Of the several products which the plant is capable of producing without any additional facilities, two are available for use as fertilizer material: cyanamide and ammonium nitrate. Although certain of its chemical properties have limited the amount that may be safely used in a ton of mixed fertilizer, large quantities of cyanamide have been used in fertilizer material. It can be produced at a lower cost than any other form of fixed nitrogen. Ammonium nitrate has not been used heretofore in commercial fertilizers to any appreciable extent. While it is entirely suitable as a plant food, its marked hygroscopic property is an obstacle to its use in fertilizers. If a way is found to overcome this property it will undoubtedly be in demand as a fertilizer material. The one product for which a market is at hand and which could be produced at Nitrate Plant No. 2 is ammonium sulphate. To manufacture this material it would be necessary to provide additional facilities at a cost of perhaps two million dollars. In case the plant is operated for the production of fertilizer material, ammonium sulphate will probably be the principal product until such time as a market is developed for other products.

The future of nitrogen fixation in the United States will depend in large measure on the relation between the demand and supply of inorganic nitrogen.

The world's production of inorganic nitrogen in 1910 was 654,000 tons. By 1913 it had increased to 823,000 tons and in 1918 it amounted to 1,300,000 tons. The increase in production was most rapid in the case of fixed atmospheric nitrogen and least rapid in the case of Chilean nitrate. The war demand increased the Chilean production only ten per cent—from 450,000 to 500,000 tons. The production of by-product ammonia increased from 220,000 tons of nitrogen in 1910 to 390,000 tons in 1920. During the same period the production of fixed atmospheric nitrogen increased from 10,000 tons to 467,000 tons.

Table 1 shows the national production capacities for inorganic nitrogen other than Chilean nitrate in 1921. It will be noted that Germany leads with more than half of the world's total capacity. The United States, Great Britain, and France follow in the order named.

Approximately one-half of the inorganic nitrogen consumed in the United States at the present time is used in the production of fertilizers. The balance is about equally divided between explosives and the chemical and other industries. The consumption in fertilizers is increasing more rapidly than the consumption for other purposes.

The enormous increase in the use of inorganic nitrogen for fertilizers is due principally to the increased use of commercial fertilizers. To some extent, however, it is due to the replacement of organic nitrogen by inorganic nitrogen. Animal tankage, dried blood, and cottonseed meal, which in the past have furnished a considerable part of the nitrogen contained in commercial fertilizers, are being used more and more for cattle feed.

The total nitrogen returned to the soil each year by fertilizers is a fraction only of that annually lost from land under cultivation. As the natural fertility of the soil decreases and the value of farm lands and farm products increases, there should be a corresponding increase in the demand for fertilizers. It is not unreasonable to expect that the use of fertilizer will grow more rapidly in the future than it has in the past, providing only that it is available in sufficient quantities and at a reasonable price.

Assuming an increase of 10 per cent per year, it has been estimated[2] that the total consumption of inorganic nitrogen in the United States will be 294,500 tons in 1924 and 438,000 tons in 1930. The estimated domestic supply of by-product nitrogen from coal for the same years is 122,500 and 159,500 tons, respectively. The difference will have to be supplied by nitrogen-fixation plants and by imports. A considerable part of the deficiency—45,000 tons—could be obtained by the operation of United States Nitrate Plant No. 2.

FIG. 3 CATALYZERS FOR OXIDATION OF AMMONIA TO NITRIC OXIDE

In the event of a future war, the requirements would be much greater. National preparedness, moreover, requires that the fixation of nitrogen be well established in the United States, so that in the event of a serious national emergency the country will be self-sustaining as regards the supply of nitrates and explosives.

The operation of the Muscle Shoals plant should contribute materially toward the building up of the nitrogen-fixation industry in this country.

[2] Consumption & Supply of Inorganic Nitrogen in the United States, by Major D. P. Gaillard, *Chem. & Met. Eng.*, vol. 22, nos. 17 and 18, 1920.

TABLE 1 NATIONAL SOURCES OF INORGANIC FIXED NITROGEN (MAXIMUM) IN 1921[1]

(Net tons of Nitrogen)

COUNTRIES	BY-PRODUCT FROM COAL	ATMOSPHERIC NITROGEN			TOTAL
		ARC	CYANAMID	HABER	
Germany	165,000	.....	132,000	330,000	627,000
United States	127,000	300	44,000	12,800	184,100
Great Britain	110,000	.....	.....	.....	110,000
France	16,000	1,400	64,000	.....	81,400
Norway and Sweden	.....	33,000	31,000	.....	64,000
Austria	11,000	.....	24,000	.....	35,000
Italy	3,000	1,300	20,000	.....	24,300
Canada	3,000	900	13,000	.....	16,900
Switzerland	.....	.....	8,000	.....	8,000
Other countries	30,000	2,800	22,000	.....	54,800
	465,000	39,700	358,000	342,800	1,205,500

[1] Calculated from data compiled in the office of the Nitrate Division, Ordnance Department, U. S. A.

Some Principles of the Construction of Unfired Pressure Vessels

By S. W. MILLER,[1] ROCHESTER, N. Y.

This paper discusses in general terms forge and fusion welding and riveting, and comments on the factors affecting welding efficiency. The composition of the best base weld metal and welding wire is touched upon and proper welding conditions mentioned. The weakness of the single "V" weld is pointed out and the use of lower-tensile-strength material advocated. The question of relieving welding strains by annealing is also treated and these and the foregoing observations are all based upon the practical experience of the writer. In considering the relative merits of welded and riveted tanks a specific instance is cited to show the superiority of the former. The results of testing welds in a Strohmenger alternating bending impact machine are also given.

There are two appendices to this paper. In Appendix No. 1 the details of the testing of ten specimens of welded plates and the results are presented along with the author's comments and conclusions. Appendix No. 2 deals with the testing of four half-inch plate-steel and two Armco iron welded tanks. The details and many photographs in both appendices capably illustrate the results and conditions under which the tests were conducted.

THE use of containers or vessels made of various materials for holding gases and liquids under pressure has been a common practice for many years. These vessels have been made of all kinds of material and with or without joints as conditions and the fancy of the designer controlled. The vessels carrying heavy pressure have been usually, in the past, of riveted construction, although forge welding of such vessels, or parts thereof, has been practiced for a long time.

Forge welding is expensive and therefore not suitable for many types of vessels. Riveted joints have also been used because of their ease of construction and of the certainty with which their efficiency may be calculated. Much of this certainty is due to our long acquaintance with them; to the many tests that have been made on them, and to the fact that they may be readily inspected both during and after their manufacture. From a construction standpoint, however, riveted joints are objectionable for many reasons, among which is their decided tendency to leak.

It must be always kept in mind also that many failures have occurred with riveted construction and that such construction is not as simple a matter as it would appear, if one were to be guided entirely by what is sometimes said. The fact of the matter is that in the case of a great many people, familiarity with riveted construction has developed a sort of contempt for the dangers accompanying it. It is only necessary to recall the protests that were made against the restrictions on double-riveted lap joints in the A.S.M.E. Boiler Code to see that this is true.

Of recent years fusion welding of such vessels, usually in steel plate or sheet, has been used to a very great extent, the welding generally being done by the oxy-acetylene or metallic-electrode arc processes. These processes, when properly applied under proper conditions, produce a safe structure that has great advantages in regard to cost, lightness, strength and freedom from possible leakage.

Single Objection to Fusion Welding

The only objection that can be raised against vessels made by fusion-welding processes is that the integrity of the weld depends very largely on the honesty and ability of the welder, because it is very difficult, if not impossible, to inspect the weld satisfactorily. This fact, coupled with accidents that have occurred have created in the minds of many a suspicion that fusion-welding processes are not safe and that pressure vessels made by their use should be condemned.

Unfortunately, it is true that there have been accidents of a more or less serious nature from defective welds, or from those improperly made. It is equally true and equally unfortunate that vessels whose parts have been joined by other means than fusion welding have been equally productive of accidents, if not more so; and while it is also true that failures of seamless vessels have occurred, yet the advocates of fusion welding cannot rely on any such statements to help their case.

The real difficulty in the case of fusion-welded pressure vessels is that the art is so new that it has not been reduced to standard practice. The first welding torch was patented in 1903 and the progress of the art was very slow at first. Really the welding of pressure vessels has not been in use to any great extent for more than 10 or 12 years, and it is hardly to be wondered at that the knowledge of the art is limited compared with the knowledge of riveted joints and of the best methods of making them. Undoubtedly, when fusion welding will have been in use for as many years as riveting, those living at that time will wonder why there was any question of the value and safety of fusion-welding processes.

But on those of us who are living now and who are interested in fusion-welding processes, lies the burden of devising means and ways of producing safe vessels, to which we can point with satisfaction and pride as being not only the equal of other constructions but far superior to them.

The two main points of superiority in such vessels are their freedom from leakage and their much greater efficiency of the joint. As in other developments of mechanical and industrial processes, much has been done in the way of fusion welding by cut-and-try methods, and those of us who have been in the business for years can testify to the difficulties encountered. These troubles only stimulated the enthusiastic worker, and methods were developed which overcame many of them, but at great expense and loss of time.

Welding Efficiency

When welding began to be studied in a more careful manner, much was said about the efficiency of a weld, i.e., the ratio of the strength of a weld to the strength of the material of which it was made.

In what follows I feel that it will be well to limit discussion to vessels made of steel plate or sheet, because it is this material and vessels made of it with which we are principally concerned. I believe, however, that the principles which I shall attempt to develop are equally applicable to other materials.

It was found by trial that the efficiency varied greatly, ranging from as low as 20 per cent to as high as 95 per cent, and sometimes higher. There was much discussion as to what percentage should be used for the design of welded pressure vessels, and it was not to be wondered at that with the wide variation in efficiency no agreement could be arrived at as to what value should be assigned to the weld.

After considerable study and experiment I arrived at the conclusion that it would be necessary to eliminate the consideration of this variable and unknowable efficiency, by either making the weld so strong that rupture could not occur there, or by making the plate so weak that rupture would occur there always. It may seem that these two statements are the same, but they are not, as will be explained later, and it has finally become very clear to me that the second statement is the basic principle for the construction of safe welded pressure vessels.

Factors Affecting Weld Efficiency

It is easy to see that the efficiency of a weld may vary for different reasons—the welder may be inefficient, the welding material may be poor, the torch or electrode may not be capable of proper operation; but beyond all these things is the fact that the mate-

[1] Proprietor, Rochester Welding Works. Mem. Am.Soc.M.E.

Abridgment of a paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of the The American Society of Mechanical Engineers. All papers are subject to revision.

rials, or base metals, which have been used for making tests vary very widely in strength. One test may have been made with 50,000-lb. material, another, with material of 65,000 lb. tensile strength. With the same welding material and the same operator the weld metal in the two cases should have the same strength. If we assume this at 50,000 lb. tensile strength, the weld in the low-tensile-strength plate will have efficiency of 100 per cent, while in the high-strength plate the efficiency would be about 77 per cent. Evidently, these two results cannot be compared unless the strength of the base material be considered. Therefore one of the first things to do is to decide what kind of material to use for the base metal.

It has been known for years that forge welding gives best results in low-carbon material, and on the other hand, tool steel is difficult, if not impossible, to forge-weld if full strength is desired. This is natural, because the high-carbon steel is easily burned at a temperature that will injure the low-carbon material but little.

In the course of my investigations I found several years ago that in two very large shops where fusion welding was one of the most important processes, they were using material of this character and had had splendid success with it. I have made numerous tests on various kinds of steel plate and found in these tests that the best welds were made in material of the same general character, that is, low-tensile-strength plate.

Composition of Best Base-Weld Metal

I have therefore come to the conclusion that the base metal most successful for welding is of about the following chemical composition:

Carbon, per cent	0.15 max.
Manganese, per cent	0.60 max.
Sulphur, per cent	0.05 max.
Phosphorus, per cent	0.04 max.

It should have about the following physical characteristics:

Tensile strength	50,000 lb. max.
Yield point	at least half tensile strength
Elongation, per cent in 8 in	$\frac{1,500,000}{\text{tensile strength}}$.

Further investigation showed, much to my surprise, that material of this composition and strength would not always weld well, and I believe I have demonstrated that there is something more necessary than the above specifications if the most satisfactory material is to be obtained.

The microscope shows that steel which welds badly contains large numbers of small non-metallic impurities, which are probably oxides or silicates, because the percentage of sulphur is too small to form so much manganese sulphide. This indicates poorly made steel and evidently the coöperation of the steel maker is needed if we are to have satisfactory material with which to work.

I have occasionally found that improperly annealed steel also gives trouble in welding even in the absence of non-metallic impurities, but not to such an extent.

I have no hesitation in saying that steel of the above chemical composition, if free from non-metallic impurities, is the best metal, in my opinion, for the making of pressure vessels.

There is another reason for this statement and it lies in the fact that such material is very ductile, and will stand punishment in the nature of overheating or mechanical work that higher carbon steel will not stand, and inasmuch as there are always strains in welding due to the contraction of the heated metal, any material that will stand these strains and absorb them is much superior to one that will not.

Much trouble has been experienced in welding long seams in such high-carbon material as ship plate, and much credit is due to those who have exercised ingenuity enough to overcome this trouble; but it is much easier, cheaper, and safer to avoid it than to overcome it, and all my experience shows that the use of the material suggested will avoid the trouble.

Welding-Wire Composition

The welding wire ordinarily used for gas welding is a low-carbon material of about the following composition:

Carbon, per cent	0.06 max.
Manganese, per cent	0.15 max.
Phosphorus, per cent	0.03 max.
Sulphur, per cent	0.03 max.

It is a very carefully made product and of superior quality, and gives very good results. In half-inch plate of sufficient strength to break the weld, it gives a tensile strength of about 52,000 lb. per in. in a double "V" weld when the weld is of equal section with the plate. I do not believe that it is strong enough, however, to allow for welds that are somewhat imperfect, if it is desired to always break the plate and never the weld.

I have therefore advocated low-carbon nickel-steel wire of the following composition:

Carbon, per cent	0.15 to 0.25
Manganese, per cent	0.50 to 0.80
Sulphur, per cent	0.045
Phosphorus, per cent	0.04
Nickel, per cent	3.25 to 3.75

This corresponds to the Society of Automotive Engineers' specification No. 2320. This material tested under the same conditions as the ordinary welding wire above mentioned, gives a tensile strength of from 57,000 lb. to 63,000 lb. in the weld.

Another Good Welding Wire

I have no doubt that other equally good or better welding materials can be devised. I know of one that is better in some respects, but it is not quite ready for the market. Tests made with it have shown an average in 12 tests of 62,400 lb. with a maximum of 64,500, and a minimum of 58,600, so that the results are quite uniform.

It should be clearly understood that I am not presenting the claims of any particular materials, but am only giving the results of my personal experience. I am advocating very strongly the use of a welding material of such character as will most easily make a sound, clean weld, of a base metal that is weak enough to absorb the welding strains and to break always outside of the weld, and of methods that will always insure these results.

Under the head of methods, the type of weld is of importance. I have demonstrated to my own satisfaction that a single "V" weld is never as strong as a double "V" weld. The latter requires twice as much welding material and is therefore more expensive. A single "V" weld cannot usually be bent backward, i.e., with the top of the "V" concave to the bend. Under such a test the chances are very great that the break will take place through the center of the weld. The reason for this is that it is impossible to get freedom from defects at the bottom of the "V." This is shown clearly by the photographs.

Weakness of Single "V" Weld

Iron oxide melts at a lower temperature than the steel, and it flows down the side of the "V," accumulating underneath the edges due to its surface tension, and when the welding rod is applied there is a film of oxide at the bottom of the "V" or under it, over which the melted metal flows, leaving a line of weakness. It also works up more or less into the bottom of the "V," leaving cracks which are frequently microscopic but none the less dangerous.

According to my observation, the ruptures of welds, not only in pressure vessels, or steel plate or sheet, but in cast iron and other metals, have been with single "V" welds. I do not recall a case of a double "V" welded piece giving way in the weld. We never use a single "V" weld if it is possible to use a double "V," even if it is necessary to weld overhead to make the bottom of the "V" sound.

Of course, where there can be no bending, as in the case of a convex head welded to a shell, there is no particular danger, especially as the fiber stress is low. Also, if the double "V" weld cannot be used for any reason, there can be no argument, but the stress must be kept at such a point as will be safe, or the design changed to permit the use of the double "V."

A double "V," on the other hand, permits of the burning out of these defects, and if any do remain, they are in the center of the weld, where their only effect is to slightly reduce the tensile strength, which can be compensated for by increasing the thickness of the

weld. This cannot be done with the single "V," because increasing the thickness of the weld on one side increases the fiber stress due to a given pressure, on account of the eccentricity of the load. This can be readily seen in the testing machine, because the test piece bends toward the bottom of the "V."

Proper Welding Conditions Essential

The use of a double "V" may not be necessary in all cases, but for all important work I am satisfied that it should be used. With double "V" welding it is necessary to clean the scale carefully from the second side welded before welding. This scale comes from the action of the air on the red-hot metal during welding of the first side, and if it is not removed it will get into the weld and make it weak and brittle. There are two reasons for this: First, melted steel will dissolve quite an amount of oxide just as water dissolves salt, but on cooling, when the metal crystallizes, it rejects to the boundaries of the grains much of this foreign material, and as it has no strength, the metal is injured; second, if the oxide is present in large enough amounts, it is included in the weld, unless great care be taken to float it to the surface of the metal during the welding, with the same result as before.

I might speak here of the necessity of forcing to the surface all foreign material during welding, as in my opinion this is an important source of defective welds. Another difficulty, which is really the same thing, is allowing melted metal to run over on to metal that has not been fused. As the latter is always covered with a coat of oxide, the result is a weak spot in the weld. It should also be noticed that the thicker the material being welded, the more liability there is of any or all of these defects occurring, and this is one reason for my belief that we should not, at the present time, attempt to use material of a greater thickness than $^5/_8$ in. for making fusion-welded pressure vessels.

Regarding the thickness of material, it should be noted that a single "V" weld in material $^5/_8$ in. thick, using a 90-deg. "V," is $1^1/_4$ in. wide. It is not possible to protect all this surface at once with the welding flame, or with the gases from the arc, and the very hot metal comes in contact with the air and is coated with oxide. The weld metal has to be remelted more or less, the amount of remelting and oxidation increasing as the thickness increases.

Again, a single "V" weld is seldom welded through, even in the best welding shops, because objection is made to any drops projecting from the inside, for reasons which are sometimes good and sometimes bad. And as it is difficult, if not impossible, to avoid these projections, the welder stays away from the sharp edges of the "V," which melt away readily, and ball up due to the surface tension of the melted metal. This balling up results in a wide opening at the bottom of the "V," which is hard to fill up. The result of not going through is an unsound weld at the bottom of the "V."

Oxides Cause Rupture

It may not be out of place to say a few words about the bearing of oxides on the weld strength. I have shown[1] that the path of rupture in steel fusion welds is first initiated at visible inclusions. If there are none of these, the next place they begin is at the grain boundaries, even when no foreign matter can be seen there at the highest power of the microscope. This is true in both gas and electric welds. It is known that such welds are overoxidized, and the inference is fair, I think, considering this and other evidence, that oxides are the cause of the intergranular rupture. It is evident that every effort should be made to keep welds as free from oxides as possible. Tests indicate that the tensile strength of an oxidized weld in $^1/_2$-in. plate is about 43,000 lb. per sq. in. The yield point of the specified base metal would be something over 25,000 lb. per sq. in., so that there is quite a margin of safety in a poor weld, as far as tensile strength is concerned, even when the weld is no thicker than the plate. It is commercially possible to reinforce a weld 15 per cent on each side, so that its section will be 30 per cent greater than that of the plate. Therefore the tensile strength of a poor weld reinforced would be, referred to the plate section, say, 55,000 lb. per sq. in., or more than that of the plate. I therefore conclude that a reasonable reinforcement of the weld is necessary for safety. The above figures are based on the use of straight low-carbon-steel welding wire. If higher-strength material be used, the margin of safety is still greater. For example, the average tensile strength of the special wire welds referred to is 62,400 and the minimum 58,600 referred to the weld section. A 30 per cent increase would mean an adjusted plate strength of about 76,000 lb. per sq. in., which is much higher than the upper limit for ship plate, 68,000 lb. From a design standpoint it is of course desirable to use as strong a plate as possible to make the vessel as light as may be. But we must be sure that the plate is always sufficiently weaker than the weld, and allowance must be made for the defects that cannot be avoided in practice.

I would again speak of the danger of assuming a weld value in design that is based on a plate stronger than the weld. Such a value is pure assumption, in spite of tests, because no account can be taken of the unknown strains in the sheet. If, on the other hand, the plate is purposely made enough weaker than the weld, there can be no danger of the weld giving way under any circumstances. If it can be shown that this can be done under usual shop conditions, it would be fair, I believe, to assign a high weld value to such construction. It should be kept clearly in mind that weld values have been in the past taken from welds made on different principles than those here advocated, and that they cannot be applied fairly under the proposed conditions. It is as if a riveted joint could be designed that had 150 per cent of the plate strength. Surely it would not be fair to assign to such a joint an arbitrary efficiency of 70 per cent.

There must be a limit to the tensile strength of a weld, and in my judgment the margin by which the plate strength should be less than the weld strength is not known with sufficient exactness to permit of any general statement being made as to its amount.

Lower-Tensile-Strength Material Advocated

Assuming that a weld 30 per cent stronger than the plate is enough to allow for usual defects in the weld, and that such a defective weld will always break the plate, we might assume that we could safely use 65,000-lb. plate, and would be safe if the weld tensile strength were 65,000 lb. per sq. in. and if it were reinforced 30 per cent. This would be true theoretically, but I am afraid of practical difficulties. The welding strains would not be absorbed by the plate as readily as with softer base metal, and there is doubt in my mind as to the welding qualities of such plate. I am strongly of the opinion that these difficulties are absent in the case of the suggested base metal. Therefore, it seems to me that till such tests have been made as will show beyond question that the use of high-tensile-strength plate is safe, we should use lower-tensile-strength material which is known to be satisfactory. It is important, however, to determine in the near future the possibilities of higher-tensile-strength material than that specified.

One precaution that should always be taken for important work is the rerolling of the shell after it is welded. The reasons for doing this are that it is impossible, particularly with heavy sheets, to roll them truly round at the ends, and the flat spots that are left there are liable to cause trouble when the vessel is put in service, due to its tendency to assume a circular section under pressure. This puts a bending stress on the weld which it is not well suited to resist, while if the shell is rerolled, the strain becomes tensile. Further, it tends to relieve the welding strain, if not to entirely remove it, and to locate defective welds.

Relieving Welding Strains

The question of annealing pressure vessels after welding, in order to relieve the welding strains, is one about which not much is really known. It would seem to depend partly on the thickness of the sheet. The thin sheet will readily distort during the welding and relieve the welding strains, while a thicker one will not do this so easily. This is another reason for limiting the thickness of the material. Another thing that influences the strain is the diameter of the shell, as a large shell will accommodate itself to the strain more readily than a small one of the same thickness.

The annealing of a pressure vessel may mean several things: First, heating of the weld and its vicinity to a sufficient temperature to relieve the welding strain; second, the annealing of the

[1] Path of Rupture in Steel Fusion Welds.—Paper read before the A.I.M.E., Feb., 1919.

weld metal to reduce the grain size to make it more ductile; third, the annealing of the metal next to the weld to remove the coarseness of the grain produced by the welding heat. There may be also combinations of any two or all three of these treatments. It should be clearly understood, however, that the temperatures for the three treatments mentioned are entirely different. The temperature for relieving the welding strain does not need to be more than a very dull red, say, not over 900 deg. fahr., and even this may not be necessary, as is shown by the fact that many cast-iron pieces are welded successfully without being heated to a dull red.

The refining of the grain in the base metal requires a higher temperature, which must be above the upper critical or Ac_3 point. This temperature varies with the chemical composition of the steel, particularly as regards its carbon content. This temperature for the steel specified in this paper is about 1525 deg. fahr.

The chemical composition of a weld varies not only with the composition of the welding wire, but also with the method of its making. However, a gas weld made with ordinary straight carbon-steel wire has a very low carbon content, not much over 0.04 per cent, and for forged material, steel of this composition would have an Ac_3 point of about 1625 deg. fahr.

It is well known, however, that a casting requires a higher refining temperature than a forging of the same chemical composition, and by test I have found[1] that a gas weld made as described has a refining temperature of about 1750 deg. fahr.

In an electric weld made with bare wire there is a large percentage of nitrogen, in some cases as high as 0.14 per cent, while the other elements are usually present approximately in the same proportions as in a gas weld.

The presence of nitrogen entirely changes the critical points, and in the case of such a weld they appear to be absent. This does not mean that the structure of an electric weld cannot be altered, but it does mean that the temperature would have to be determined by experiment.

In the case of nickel-steel welding wire, the weld contains over $2^1/_2$ per cent of nickel. Nickel lowers the upper critical point, depending on the amount of nickel present—in this case, about 50 deg. fahr.

It will therefore be seen clearly that annealing for any purpose except relieving the strains is impossible from a commercial point of view, as it would involve a double heat treatment.

It is evident that it is not necessary to heat the whole vessel for the purpose of relieving the welding strains, and probably a dull red heat for a distance of 2 in. or 3 in. on each side of the center line of the weld in $^1/_2$-in. material would be sufficient.

It is doubtless true that either annealing and rerolling can be omitted in some cases, and that neither of them would be required for safety in other cases. But it seems clear that the higher the tensile strength of the plate, the greater the necessity of taking these precautions. A further reason for using low-carbon sheet is that it is not liable to be injured by the welding heat as much as higher-carbon material.

It may be objected that the carrying out of these principles will be so expensive as to make it commercially impossible to use fusion welding for pressure vessels. There are two answers to this. First, the burden of proof of the correctness of the statement rests on those who make it, and until proof is given of its correctness, the mere assertion is not evidence. Second, if it be true in any case that safe practice (and this does not of necessity include all the precautions mentioned for every case), makes welding too expensive, then it is obvious that welding cannot be used.

Further, there is involved the matter of salesmanship. If we believe that a properly welded vessel is better and safer than a riveted one, we should be able to sell it in all cases where it is worth the price, and if it were not worth the price, we could not honestly urge its installation.

It is quite possible that poorly welded pressure vessels are much cheaper than well-riveted ones, and that this has been used as a means of reducing prices in some cases. But if this be true, those responsible for the poor welding cannot come into court with clean hands, and their arguments would be invalid. Fortunately, such arguments are rarely heard, but unfortunately, we must make specifications which guard against such possibilities.

[1] Journal of the American Society of Refrigerating Engineers, Nov., 1918, p. 202.

WELDED VS. RIVETED TANKS

It may be of interest to consider the relative merits of welded and riveted tanks as far as strength is concerned. Only one instance will be given. Assume the riveted tank to be double lap-riveted of $^1/_2$-in. plate of 60,000 lb. tensile strength, and 5 ft. in diameter. With a factor of safety of 5, it would be good for 140 lb. working pressure by the usual formula. If the welded tank were of the same dimensions of 50,000-lb. plate, with a weld strength of 125 per cent of the plate, which is easily obtained, it would be good for 141 lb., if a weld efficiency of only 85 per cent were assumed, using the same factor of safety and formula. I really believe that the welded vessel is far superior to the riveted one in this case, in every way.

Objection has been raised to the use of welding because of the small resistance of welds to alternating stresses and shocks, to which any pressure vessel is subject in service. It is true that if the base metal is stronger than the weld, the weld readily gives under such stresses, but it does not seem to be so if the base metal is weaker.

In order to determine whether the ideas which I held were correct, a number of welded plates were tested and then later further tests of actual pressure vessels were conducted. The complete results of both sets of tests are presented in the appendices to this paper, selections from which appear in the present abridged publication.

Also through the courtesy of the Quasi Arc Weldtrode Co. a number of tests were made in their Strohmenger alternating bending-impact machine, especially designed for testing welds. The test piece, $^3/_8$ in. by $2^1/_2$ in. in section, with the weld machined flush with the base metal, is clamped in the jaws, with its edge level with the center of the weld. The vibrating head is loose on the test piece, the opening being $^1/_2$ in. wide. The head travel is so adjusted that the test piece bends $^5/_{32}$ in. on each side of its central position, so that the travel before impact is $^1/_8$ in. and the total bend $^5/_{16}$ in. The number of alternations is about 600 per minute. Of course, no quantitative results can be obtained, but the results were quite consistent in the forty-two tests which were made.

One set of tests was made with two welding wires, an ordinary low-carbon steel, and 3.5 per cent nickel steel. Two base metals were employed, and 3 test pieces were made with each combination, a total of 12. The results of this series were as follows:

Base metal	Welding rod	Average no. of alterations before rupture	Broke
57,000 lb. tensile strength, bar steel	Carbon steel	3300	all in weld
57,000 lb. tensile strength, bar steel,	Nickel steel	5600	all in weld
47,000 lb. tensile strength, plate,	Carbon steel	4550	all in weld
47,000 lb. tensile strength, plate,	Nickel steel	8550	all out of weld

These results show clearly the superiority of the low-strength-plate—high-strength-weld combination. It might be said that the unwelded plate gave about the same results as did the nickel-steel welds.

It seems clear that the stiff nickel-steel weld threw the strain into the soft plate, which broke just next the weld in the zone coarsened by the heat, and if this zone has about the same resistance as the solid plate, as the tests indicate, there can be little fear of danger from alternating stresses in service in a vessel made in the same way. It should be remembered, however, that the higher the tensile strength of the plate, the higher the carbon content, and therefore the greater danger from the welding heat, especially if the heat be applied rapidly and the cooling occur quickly. This has resulted in ruptures in heavy boiler plates, say $1^1/_{16}$ in. thick, due to the formation of a sorbitic zone next the weld, and to the strains set up in the sheets by the weld shrinkage. This trouble can be avoided by preheating sufficiently to avoid forming sorbite, which requires a rather rapid rate of cooling for its formation. This sorbitic condition would doubtless have an effect on alternating-stress tests, and such tests should be considered a necessary part of any program for studying the value of plate for welding purposes.

APPENDIX NO. 1

TESTS OF WELDED PLATES

In order to determine whether the ideas which I held regarding fusion welding of unfired pressure vessels, were correct, I took up the matter with H. S. Smith, then president of the International Acetylene Association and Prof. C. A. Adams, director of the American Bureau of Welding, and with their coöperation a number of tests were conducted.

Altogether there were ten plates tested and a summarization of the general results is given in Table 1.

Specimen B, from the York Mfg. Co., was purchased with the understanding that it was same general type of material as the others, but on analysis it was found to contain 0.24 per cent carbon and to be of about 64,000

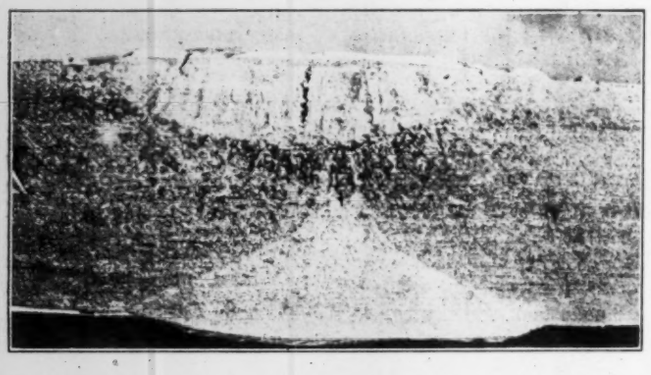

FIG. 1 CRACKS IN WELD OF SPECIMEN B; MAGNIFICATION 2.3

lb. per sq. in. tensile strength. The ground test piece broke in the weld at 58,000 lb. Another cold-bend test piece of another exactly similar weld in another plate of the same material broke outside of the weld and the hot-bend test piece bent flat on itself, without cracking.

Probably the most interesting case of the ten specimens tested is that of specimen B, in which cracks were found in the plate at a distance up to 3/4 in. from the edge of the weld, which could frequently be seen with the naked eye and which were readily visible with a magnifying glass (Figs. 1 and 2). It should be noted that the plate had not been fused where the cracks occurred. Examination was made of these cracks by taking a section through them and examining under the microscope.

The pieces so examined were taken from another test plate made of the same steel and in the same way, the test pieces having been strained in a 50,000-lb. testing machine, which was not sufficiently strong to break them, but which did open up the cracks referred to so that they could be seen. These cracks (Fig. 3) apparently only occurred on the second side welded, and are probably caused by the resistance to shrinkage due to the stiffness and strength of the plate, although the poor general quality probably had also a considerable effect. I had never noticed such cracks before, although I have since found them in sheet material of poor quality.

Microscopic examination of the section taken through one of these cracks is very interesting. The plate, as received, was quite heavily coated with mill scale, which had been rolled into the surface. This is brought out by the pickling. An examination of the weld with a hand glass shows quite clearly that this mill scale has been fused in the vicinity of the weld. Of course the temperature of the plate near the weld was high, probably 2300 deg. fahr. or 2400 deg. fahr., which would be sufficient to melt the scale. Also the plate at that temperature was in the γ range.

At this high temperature the crystallization of the metal is different from that at room temperature in that the grains are of different shape and larger, and that the carbon is all in solution in the iron. The weld having been made on one side, the plate is rigid and the expansion due to the heat compresses the metal where it is weakest, that is, hottest, and when it cools the contraction occurs at the same place. If the strain is great enough, the plate cracks if it is not sufficiently ductile. If the metal were of poor quality, and brittle at high temperature, the condition would be worse. In either case, capillary attraction might draw the melted scale into the cracks.

At this high temperature the solvent power of the iron for impurities is considerable, and it is quite reasonable to suppose that some of the mill scale was dissolved. As the metal cools, some of the oxide would fall out of solution, and be rejected to the grain boundaries then existing, that is the austenite or γ ones. Even if this did not occur, the strain might cause minute cracks, the surfaces of which would oxidize easily. Whatever occurred, the recrystallization that took place later in the cooling, when the metal passed from the γ to the α condition, could not pass these impurities, which outlined the γ grains, and which, when the metal was cold, showed their location.

It is well known that tool steel, when burnt, shows such markings around the grains, these being sharply angular instead of being rounded as the alpha grains are. I sectioned one of the pieces through one of these cracks in the plate, and in examining it at low power I noticed a network which did not coincide with the α grain boundaries. Higher power showed it to be apparently a film of oxide. Still higher power seems to confirm this.

Microphotographs are given showing the structure. Fig. 4 shows that the network is quite extensive, being to the right of the large crack which is the result of the tensile test of the material. I have no doubt that originally this crack was not much larger than the network. Fig. 5 shows part of the network at a higher magnification, and Fig. 6 at still higher power. Figs. 5 and 6 show quite clearly that the pearlite and cementite do not lie at the films and in some case the α grain boundaries can be readily seen. They are clearly different and distinct from the films.

A section from sample No. 1 of specimen B showed no cracks in the plate, but some few in the weld, which were about 1/200 in. deep. In some cases it appears that these cracks pass through the center of particles of cementite as shown in the photograph (Fig. 7). Whether the cementite was actually ruptured or not is a question, although I am inclined to think that it was. This would require the rupture to have occurred, at least partly, below the Ar_1 point. It is of course, possible that the main part of the crack occurred at high temperature and that it extended at a lower temperature. These cracks are very small and have no apparent effect on the strength of the welded piece, because even when the welds were ground down level with the plate, the plate broke in the middle third between the weld and the shoulder in a natural, normal manner.

These cracks are also very shallow, and most of them are filled with oxide, showing that they occurred at high temperature. The weld scale is very adherent, requiring for its removal much longer pickling in dilute hydrochloric acid than ordinary weld scale. It appears to run down into the cracks as a continuous part of the surface scale in some cases, and there are in the surface scale particles of metal.

Sample No. 2 of specimen B appeared from general observation not to be of good steel. The fractures in the tensile test pieces were not silky as they should be, but were more or less harsh to the eye. It is worth noticing that welds made with nickel steel wire, in 64,000-lb. plate, the welds being reinforced the usual amount, broke the plate outside the weld with the same necking down as would be expected in an ordinary tensile test.

Leaving aside for the moment the question of welding, it would seem that we must pay much more attention to the quality of the steel used for welding than we have in the past, and this brings up the question of some of the mysterious failures of boiler shells, ship plates, etc., and I am inclined to believe that much of the trouble has come from defective steel; the defects have not been detected, and they probably could not be detected, by any ordinary examination or the regular tests.

There was, for instance, the quite noted case[1] of the plate failures on a ship being built in England, which gave trouble from brittleness after having passed all Lloyd's tests successfully. This case was investigated by some of the ablest metallurgists in England, and the consensus of opinion appeared to be that the plate was from a basic open-hearth heat that had not been properly treated with manganese and was otherwise badly made.

Attention was called to the remarkable angularity of the grains. It was found by analysis that the steel was very high in oxygen and nitrogen.

[1] The Remarkable Failure of a Consignment of Ship Plate, by J. B. Wilson. Proceedings of Engineers & Shipbuilders in Scotland, 1914, p. 227.

TABLE 1 RESULTS OF TESTS OF WELDED PLATES

Specimen	Sample	Lb. Per Sq. In.		Per Cent		Weld Ground	Location of Break
		Tensile Strength	Yield Point	Elongation in 8 in.	Reduction of Area		
A	1	50,900	32,400	25.7	.....	no	3 in. from weld
	2	50,500	31,400	27.1	.....	yes	2½ in. from weld
	4	51,000	32,000	29.0	.....	yes	3 in. from weld
B	1	58,500	43,100	4.25		yes	In weld
	2	64,000	41,300	19.6	53.6	no	1½ in. from weld
	4	63,700	41,500	23.5	53.1	yes	3 in. from weld
C	1	29,750	27,300	2.3	4.2	yes	In weld
	3	31,700	27,100	3.4	4.7	yes	In weld
	5	41,100	27,100	6.6	10.6	yes	In weld
D	1	48,100	30,500	26.0	4.5	yes	2 in. from weld
	3	47,250	30,300	27.0	3.2	yes	2 in. from weld
	5	49,100	29,100	29.7	2.9	yes	2 in. from weld
E	1	51,100	32,930	31.0	59.0	no	1½ in. from weld
	2	51,680	32,700	26.6	58.4	yes	1½ in. from weld
	4	51,320	32,000	25.0	61.2	yes	Outside of weld
F	1	42,570	.....	21.9	61.15	yes	Outside of weld
	3	43,210	.....	25.9	63.4	yes	Outside of weld
	5	43,040	.....	24.0	61.5	yes	Outside of weld
G	1	50,000	31,400	.....	60.7	no	2½ in. from weld
	2	52,560	32,700	24.3	57.6	yes	2½ in. from weld
	4	52,200	31,380	24.6	53.6	yes	2½ in. from weld
H	1	39,300	.....	6.7	2.46	yes	In weld
	3	45,830	.....	21.9	67.95	yes	Outside of weld
	5	44,740	.....	11.8	3.63	yes	In weld
I	1	43,050	.....	24.4	64.35	yes	Outside of weld
	3	42,430	.....	22.9	67.6	yes	Outside of weld
	5	42,490	.....	15.1	.....	yes	In weld
J	1	40,850	.....	12.1	2.53	yes	In weld
	3	44,150	.....	22.5	73.7	yes	Outside of weld
	5	43,670	.....	22.2	70.9	yes	Outside of weld

Analyses were made by a number of chemists and the results not only showed the above, but that the steel was badly segregated. While the standard tests did not show anything wrong with this material, alternating-stress tests did show clearly that the metal was inferior, and the matter is referred to, not with the idea of trying to include such tests in specifications, but to show that at times more searching tests than the usual ones may be needed.

In many other cases in the literature this same angularity of grain is noticed in photographs, even if no reference is made to their shape in the text, so that angular grains would be indicative of poor material. It would seem that they represent the γ grain boundaries, and not the α ones.

I do not doubt that invisible intergranular films may exist along the γ grain boundaries in many cases, which would open paths for oxidation when heated or which under severe strain might result in rupture, particularly if the strain were accompanied by shock. I am convinced that such is the case in welds, because I have broken many pieces under the microscope, and even where there was no evidence of intergranular films at 1200 diameters, the rupture was generally along what are apparently the γ grain boundaries.

TABLE 2 A.S.T.M. SPECIFICATIONS FOR FLANGE AND FIREBOX STEEL

Kind of Steel	Flange Steel	Firebox Steel	Remarks
Carbon, per cent	.....	0.12 to 0.25	Plates $\frac{3}{4}$ in. thick or less
Manganese, per cent	0.30 to 0.60	0.30 to 0.50	Plates $\frac{3}{4}$ in. thick or less
	0.30 to 0.60	0.30 to 0.60	Plates over $\frac{3}{4}$ in. thick
Phosphorus, per cent	0.05 max.	0.04 max.	Acid
	0.04 max.	0.035 max.	Basic
Sulphur, per cent	0.05	0.04	
Tensile strength	55,000 to 65,000	52,000 to 62,000	lb. per sq. in.
Yield point	0.5 ten. strength	0.5 ten. strength	
Elongation in 8 in.	1,500,000 / ten. strength	1,500,000 / ten. strength	Minimum per cent

There are three classes or qualities of steel plate, called flange, firebox and tank. The specifications[1] of the American Society for Testing Materials for the first two are given in Table 2.

Steel of tank quality has no specification. It may have as high as 7500 lb. tensile strength and be full of impurities, and is entirely unfit for important work. It is made from heats that for some reason are off.

Firebox steel is evidently of better quality from its composition, having less phosphorus and sulphur. But there are further differences that are hard to describe, and which are usually known only to the mill. For much work, flange quality is plenty good enough, while for the better work, firebox quality is needed; but in my judgment the tensile strength and carbon are too high in the A.S.T.M. specification for really important work, and the specification proposed earlier in the paper I believe to be much more suitable. In any case, high quality is essential to the best work, and for such work firebox steel should be specified.

This matter of quality, as distinguished from chemical composition, has been referred to at some length, because my experience has been that

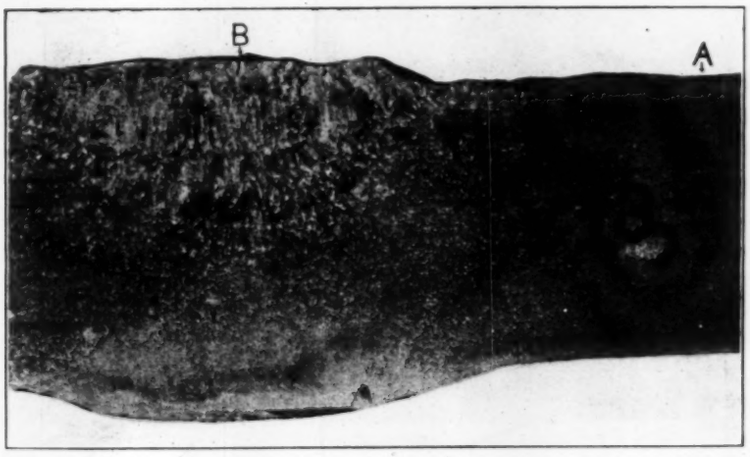

FIG. 2 CRACK IN BOTH PLATE AND WELD OF SPECIMEN B; MAGNIFICATION 3.2

it affects the quality of the weld. This is especially true where the metal contains notable amounts of what Brearley calls "mechanical dirt." It is coming to be believed more and more that oxides of various kinds are largely responsible for the poor quality of steel, and I have found that steel containing this dirt foams and spits during the welding, and that the welds made in it are weak. Of course all steel plate contains some impurities, and it is very hard to say how much to allow, or how to draw a specification limiting the amount. But steel of firebox quality never gives any trouble, as far as I know, and I believe that we will be safe if we specify it for important work.

The superficial cracks in the nickel-steel welds referred to are not found in all cases, and they are rare in welds made with ordinary materials and their presence is not fully understood.

The important thing is to provide a weld that will be sufficiently strong even when somewhat defective, and the base metal so weak that it will take the strain in preference to throwing it in the weld. I do not believe that these minute cracks in nickel-steel welds are any different from those occurring with ordinary welding material. This is not saying that welds free from them are not desirable because they are, but nickel steel should not be condemned on this ground alone, any more than should ordinary welding material, because the cracks have occurred in both.

The cracks in the plate of specimen B are of particular interest, because they show necessity of having the base metal of such a quality as will not be injured during the welding, and it is significant that none of the other plates had them, though they were looked for very carefully. We must not forget that special materials have had to be developed for specific processes,

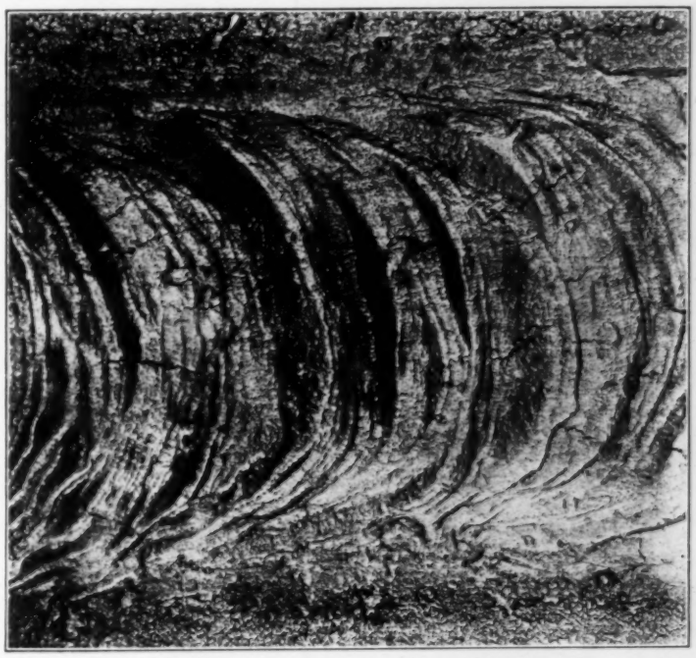

FIG. 3 CRACKS IN WELD AND PLATE AFTER 50,000-LB. TENSILE LOAD FAILED TO BREAK TEST PIECE. SCALE PICKLED OFF BEFORE TAKING PHOTO; MAGNIFICATION 3.6

for instance, the use of bessemer steel is general for screw-machine stock, because the chips from it break up readily and do not clog the tools. In the same way, we must have for welding purposes a steel that meets the requirements. Fortunately, such steel is not difficult to obtain, and the steel maker will be glad to furnish it if he knows what the requirements are, and it is our business to advise him of them.

Any welding wire used must be of good and uniform quality if good results are always desired. I have found very bad results from some nickel-steel rod. I cannot say yet where the trouble lies, but it does not appear to be entirely dependent on the chemical analysis, and I have no doubt that the general quality of it and other wires will be found just as important in all cases as I know it is in some.

It should be clearly understood that I do not believe nickel steel to be the best welding material that can be made. I have had great success with it, and it is to my mind the best material now readily available for high-strength welds. But I would be glad to see other wire giving similar high strength, because it is very probable that still better qualities can be obtained by other alloys than nickel. It is just as important to have suitable wire for welding pressure vessels as it is to have suitable plate, and if our needs are realized they will be met.

I feel very strongly that some method of protecting the weld from the action of the oxygen in the air or in the welding flame must be used, if we want the highest efficiency. I do not mean that we cannot make safe pressure vessels now, because we can and it is being done every day, but we want to do better.

The following general conclusions may be drawn from these tests:

a If the weld is ground to the same thickness as the plate, the break will probably occur outside of the weld.

b Since all welds not ground flush broke outside of the weld, it is highly improbable that any double "V" welded piece of low-strength plate and properly reinforced will break in the weld.

c Bare-wire arc electric welding is not practical with a nickel-steel rod.

d Arc welds made in low-strength plate with proper electrodes and reinforced will always break the plate under tensile test.

APPENDIX NO. 2

TESTS OF WELDED PRESSURE VESSELS

Further tests of actual pressure vessels were later conducted to determine whether theories were borne out in practice. Six tanks were tested, of which four were made of firebox steel showing on chemical analyses of ladle tests to have the following composition: Carbon 0.12 per cent;

[1] A.S.T.M. Specifications 1921, p. 230.

manganese 0.38 per cent; phosphorus 0.012–0.015 per cent, and sulphur 0.028–0.035 per cent.

Tensile tests at the mill gave the following results:

	Longitudinal	Transverse
Tensile strength, lb. per sq. in.	48,100–49,260	52,700
Yield point, lb. per sq. in.	36,900–36,200	37,000
Elongation in 8 in., per cent	31–30	30

These four tanks were welded with ⅛-in. diam. nickel-steel wire of the following composition: Carbon 0.21 per cent; manganese 0.60 per cent; phosphorus 0.025 per cent; sulphur 0.023 per cent and nickel 3.20 per cent. A No. 8 D-B tip, having a mixing chamber 0.098 in. diam., and the flame adjusted to suit the idea of the welder was used. A 90-deg. double "V" was used for the longitudinal seam, which was made with a cutting torch, and the scale carefully removed as much as possible with a chisel and wire brush. While the thin scale could not be taken off, all the large particles were removed. The head seams were 90-deg. single "V," made and cleaned in the same way.

It was thought desirable to get some information about the shrinkage of the welds, so tram marks were made at different places along the seams on the outside of the shell, after the first side of the longitudinal seam was welded, with a tram 5 per cent long, so that the marks were about equidistant from the center of the weld. The same tram was used on the head seams after the heads were tacked in place, and before welding. The circumference of the tank was measured with a steel tape just inside each head seam, and at 3 other places, equally spaced, between the first two.

There were five welders used at different times on the work, which was done at the Rochester Welding Works. Their records bearing on their ability for the work, are as follows:

A Six years' experience. All-around job welder. Had welded heavier steel plate but very few pressure vessels.

B and *D* Four years' experience. All-around job welder. Had never welded plate as heavy, and never welded pressure vessels.

C Six years' experience. Good job welder, and had welded many pressure vessels up to ⅜-in. plate thickness, but never thicker.

E Four years' experience in pressure-vessel welding but never in over ⅜-in. plate.

These records show that none of these men could be called experienced on the job at hand.

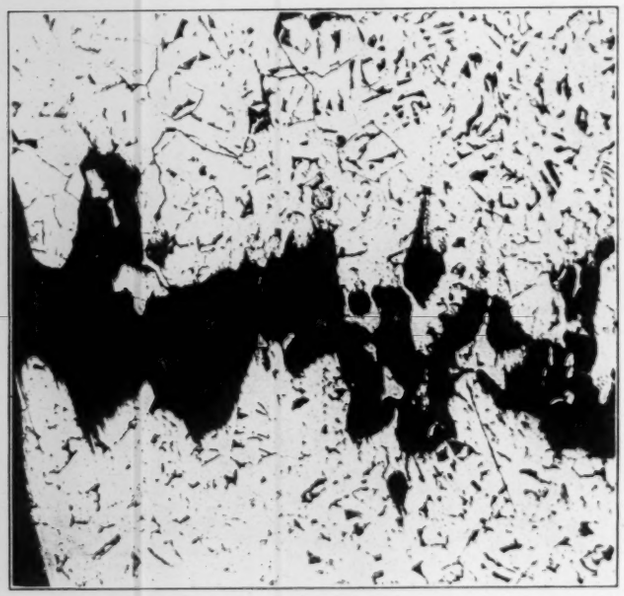

Fig. 4 Crack of Specimen B Opened by Strain. Originally of Same Character as Network at Right Which Outlines the γ Grains. Etched With Picric Acid; Magnification 100

Fig. 6 Magnification of Portion of Fig. 5, Showing Details More Clearly; Magnification 1200

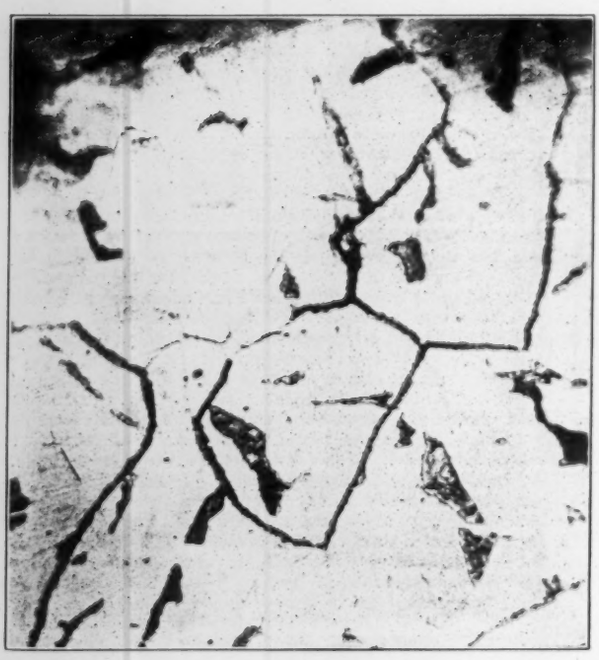

Fig. 5 Specimen Shown in Fig. 4 at Higher Magnification. Films of Oxide at γ Grain Boundaries are Very Clear and α Grains Can be Seen With Pearlite Lying at Outer Edges; Magnification 430

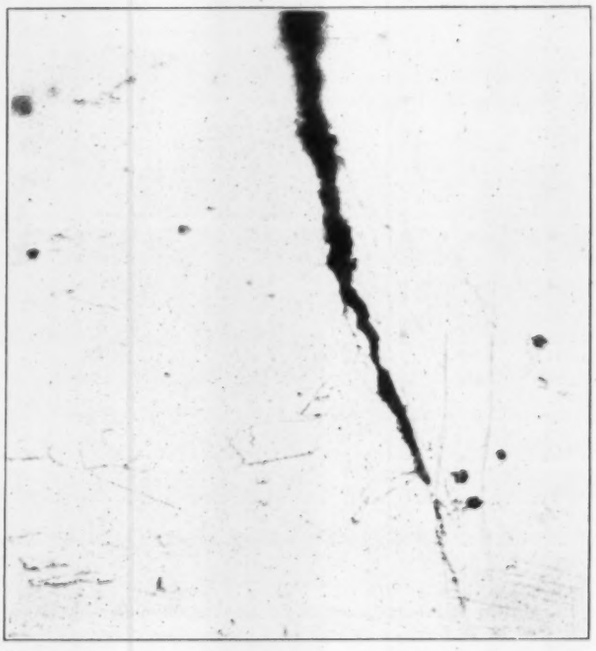

Fig. 7 Bottom End of Crack in Weld, Extending Through Cementite Which the Crack Appears to Have Split. Etched With Picric Acid; Magnification 1200

In all the tanks, records of time and welding rod used were taken, but are not given because of the great variation in the fitting up, so that comparisons of the welders based on these figures would be unfair.

Only three of the tanks were tested, because the pump was not of sufficient capacity to burst them in any reasonable time, although it was good for 2500 lb. pressure. It is hoped that a larger-capacity pump will be obtained soon and the test finished.

Tank No. 1 longitudinal seam was welded by *A* and *B*. The seam fitted so badly that it had to be wedged against a 70-lb. rail, after clamping the ends together, and to the rail, to straighten it, and even then *B*'s end did not line up well. No tacking was done, and the welding was begun inside at the center of the length, both welders working toward their ends, using the backward method. The seam was allowed to cool over night and the tram marks (Fig. 8) and measurements made as mentioned above. The same men welded the outside of the seam, again working backward, beginning again at the center at the same time, and working toward the ends. The measurements were taken again after the shell was cold.

The heads (Fig. 9) were then tacked in place, with tacks from 9 in. to 12 in. apart, leaving the bottom of the "V" $\frac{1}{8}$ in. open before tacking. The tacks were somewhat over 1 in. long. The tacking and welding were done by *C*, who used forward welding. After tacking, the tank was allowed to become cold, the tram marks applied, and the welding finished. When cold, the measurements were again taken.

The pipe connections for testing were of $\frac{1}{2}$-in. extra heavy pipe, and were threaded in place, and gas-welded inside. The one in the center of the head was badly located for the test, as will be seen later, but would have been perfectly safe in service. An additional set of tram marks was put on this tank at the points where the circumference was measured. They are shown in Fig. 14 and were for the purpose of getting the elongation at and near the weld, if possible. The marks were on 2-in. centers, and the total length between the outside ones at each point was 10 in. All the tram marks on the shell were really chordal distances, but the errors of reading them were doubtless more than those due to their being chords instead of arcs.

All marks were laid out with a tram or dividers, and a jeweler's glass used to read them with a scale graduated to hundredths of an inch. The steel-tape measurements were read to the closest thirty-second of an inch. The shell not being round, it was only possible to divide up the inequalities between it and the heads as well as could be done. After the welding was done, the shell at the longitudinal seam was 0.21 in. higher than the head at one end, and 0.25 in. at the other. Similar variations occurred in the other tanks.

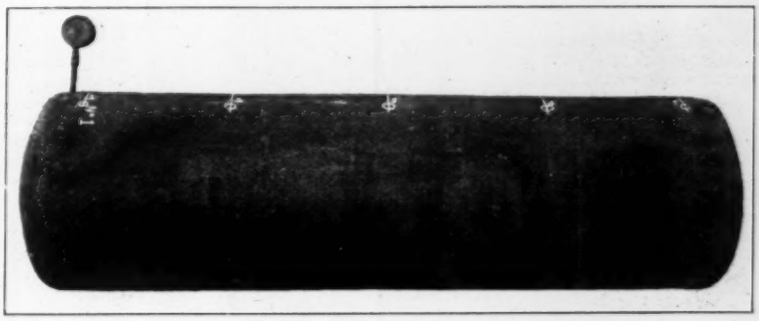

FIG. 8 NO. 1 TANK (SAME AS NOS. 2, 3 AND 4) SET UP FOR TEST. FIGURES 1 TO 5 LOCATE TRAMMING POINTS AT SEAM

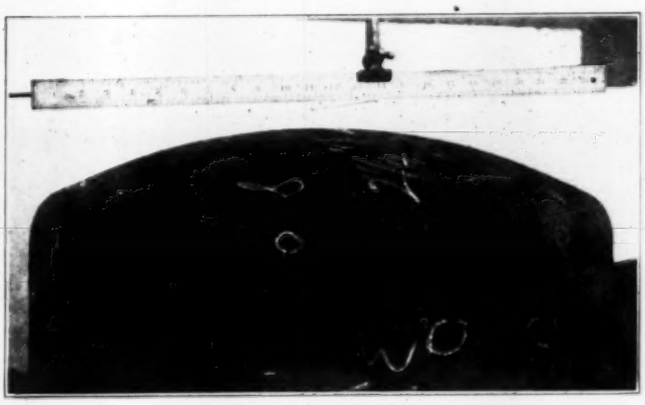

FIG. 9 HEAD OF TANKS NOS. 1 TO 4, SHOWING RADIUS BEFORE TESTING

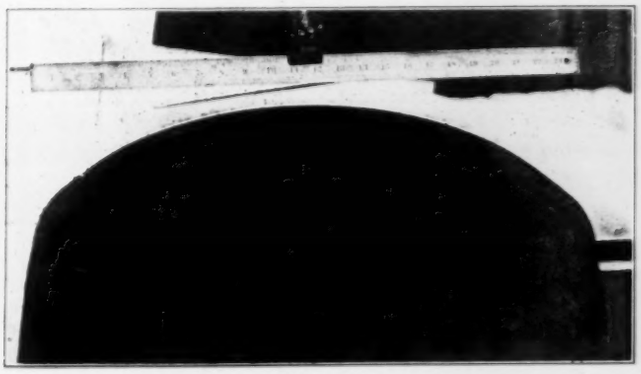

FIG. 11 HEAD OF NO. 1 TANK AFTER TESTING TO 2150 LB.; RADIUS ABOUT 19 IN. NOTE THAT DIAMETER OF THE HEAD FLANGE DECREASED FROM THE WELD OUT

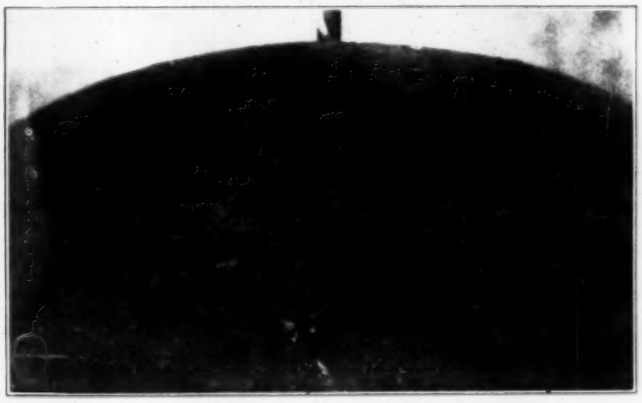

FIG. 10 LUDERS' LINES ON KNUCKLE OF TANK NO. 1 AT 1150 LB. LIGHT DIAGONAL LINES INDICATE A STRETCHING OF THE METAL DUE TO STRESS PERPENDICULAR TO THEM

FIG. 12 HEAD OF TANK NO. 5 BULGED AFTER TEST. ORIGINAL RADIUS 35 IN., FINAL RADIUS 19 IN.

FIG. 13 ONE SEAM OF TANK NO. 5 AFTER TESTING TO 1900 LB. NIPPLE AT LEFT TAPPED IN AND ARC-WELDED, AND ONE AT RIGHT TAPPED IN AND GAS-WELDED INSIDE. NOTE DISTORTION OF ENDS

The testing was done with a motor-driven pump, which was found too small on the first test. A second one was built, and while it had sufficient strength, it did not have enough capacity to burst the shell, which, with the heads, simply stretched, with very little effect on the welds. This was true throughout the tests.

In no case could the welds be injured beyond the formation of minute pinholes or cracks, which, while they helped to keep the pressure down, at no time gave any evidence of any general rupture. These small cracks did not appear in any case until a very high pressure had been reached, the lowest being 1350 lb. This pinhole was stopped with one blow of a center punch, and did not appear again until the pressure reached 2100 lb. This means a fiber stress of about 31,000 lb. when the pinhole appeared, and of about 48,000 lb. when it showed up the second time. The fiber stress of 435 lb. working pressure is 10,000 lb.

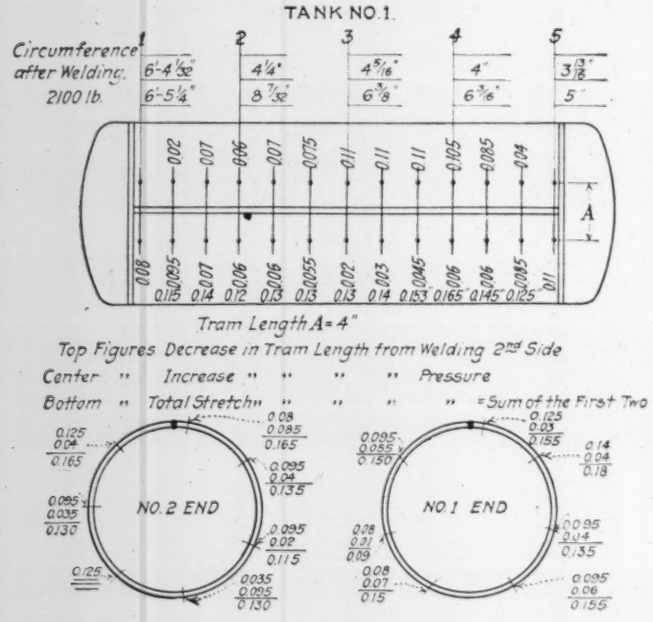
TANK NO. 1
Circumference after Welding, 2100 lb.
Tram Length A = 4"
Top Figures Decrease in Tram Length from Welding 2nd Side
Center " Increase " " " " Pressure
Bottom " Total Stretch " " " " = Sum of the First Two
NO. 2 END
NO. 1 END
Top, Center, and Bottom Figures mean same as above, for Tram Lengths across Head Seams
Tram Length 2" in all Cases. Figures are Increase over 2" due to Pressure

FIG. 14 TRAM MEASUREMENTS OF TANK NO. 1

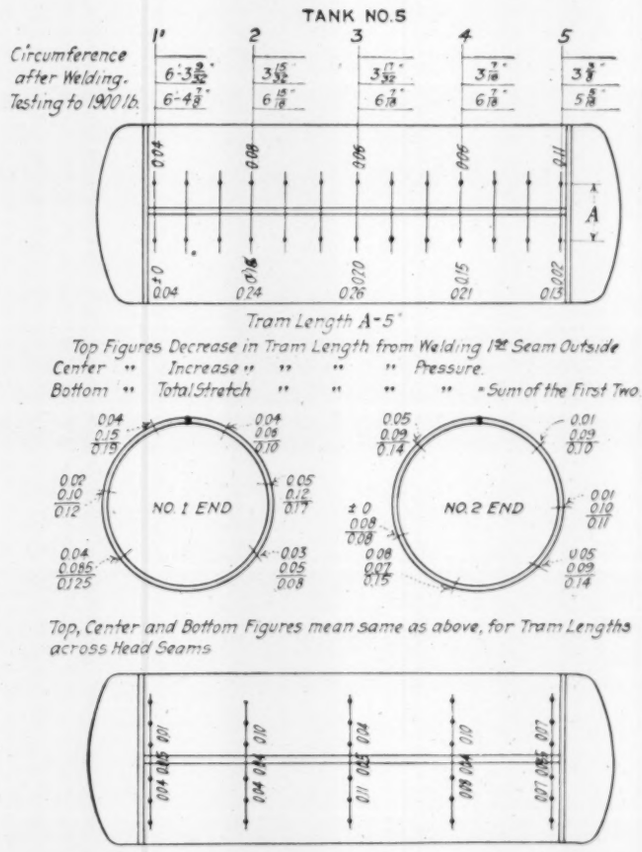
TANK NO. 5
Circumference after Welding, Testing to 1900 lb.
Tram Length A = 5"
Top Figures Decrease in Tram Length from Welding 1st Seam Outside
Center " Increase " " " " Pressure.
Bottom " Total Stretch " " " " = Sum of the First Two
NO. 1 END
NO. 2 END
Top, Center and Bottom Figures mean same as above, for Tram Lengths across Head Seams
Tram Length 2" in all Cases. Figures are Increase Over 2" due to Pressure on 2nd Seam

FIG. 15 TRAM MEASUREMENTS OF ARMCO TANK NO. 5

The details of the test are as follows: The pressure was raised to 800 lb. and the seams then struck good swinging blows with an 8-lb. sledge. The pressure fell to 750. The pressure was increased, and at 1150 lb. Luders' lines appeared in the scale on the knuckle of the head, as shown in Fig. 10. At 1450 lb. a few drops of water appeared at the pipe nipple in the center of the head, but this leak stopped at 1500 lb. The yield point of the tank was very clear at 1500 lb., at which point the pressure was steady for a long time, while the heads could be seen stretching. The shell also took a slight permanent set, as will be seen from the following tabulation.

Circum. in.	Before test	At 400 lb.	At 800 lb.	At 1200 lb.	At 1500 lb.	At 1500 lb.[1]	After test	After 2150 lb.	Total stretch
1	76 1/32	76 1/16	76 1/8	76 1/16	76 1/16	76 1/16	76 1/16	77 1/16	1 1/32
2	76 1/4	76 1/4	76 1/4	76 1/4	76 1/2	76 5/8	76 3/4	80 3/32	3 11/32
3	76 3/16	76 11/32	76 11/32	76 11/32	76 11/32	[2]77	76 11/32	78 3/8	2 1/8
4	76	75 31/32	75 31/32	76 1/32	76 1/16	[2]76 11/32	76 3/8	78 1/16	2 1/16
5	75 31/32	75 31/32	75 31/32	75 31/32	76 1/8	76 1/32	76 1/16	77	1 1/16

[1] After prolonged application of this pressure.
[2] Flat spot in this vicinity had straightened out.

1500 lb. corresponds to a fiber stress of about 33,000 lb., as close as could be expected to the tests of the plate.

The pressure was raised very slowly to 1750 lb., at which the pump broke down and the test was stopped for the time being. The pipe nipple in the center of the head was removed and placed in the shell about 4 in. from the head seam, because the bulging of the head had opened the thread in the sheet away from that on the nipple. It was tapped into the shell, and a heavy boss electrically welded around it. There was no further trouble with it. Nor was there any leak at the other nipple, which was threaded in flange of the head and gas-welded inside before the head was welded to the shell.

A further test was made with a new pump, the pressure being raised to 2150 lb., without any leaks. The tank was continually stretching (Fig. 11) and at this pressure a small crack appeared in the longitudinal seam 18 in. from one end, and a very small pinhole in the head seam 12 in. from longitudinal seam. On account of these leaks the pressure dropped to 2100 lb., and the test was stopped. 2150 lb. corresponds to a fiber stress of about 49,500 lb. very close to the ultimate strength. The tram measurements are all given in Fig. 14. The remaining two tanks, numbered 5 and 6, were made of two pieces of Armco iron requiring two longitudinal seams.

The pressure was carried up to 800 lb. and the sledge test applied with no sign of failure. At 500 lb. Luders' lines appeared on the heads, and on account of their long radius, they bulged rapidly, and it was difficult to detect the yield point of the shell. It was probably at about 1100 lb. There was an increase of 1/2 in. in circumference at the center at 1250 lb.

At 1750 lb. a small crack, due to a lap on the inside of the seam, appeared, and the pressure was released, the defective part cut out and welded up. The pressure was increased to 1900 lb., when the weld in the center of the head, where the pipe-nipple hole had been welded up, gave way in a small crack. This, and the fact that the tank was stretching, made it impossible to continue the test. The fiber stress at 1900 lb. is about 43,800 lb., and as the tensile strength of Armco iron is about 44,000 lb., it is probable that the tank would eventually have given way at about this pressure. Figs. 12 and 13 show the results of the test.

It should be noticed that during the welding of these tanks almost everything was done that should not have been. The plates were badly rolled, they were out of line and flat, and fitted up badly. The "V's" were made with a cutting torch, and the welding was done with little regard to method and system. There was no preheating of the seams when the second side was welded, nor were the seams annealed or the shells rerolled to bring them more nearly to a truly circular shape. Also the heads did not fit the shells, as the latter were not circular. All of these were bad practices for a vessel designed for high-pressure work.

There were, however, four precautions taken. The plate was of low tensile strength, the wire of high tensile strength, the weld double "V," and the welding well done. So that in spite of the bad practices, the results are, in my judgment, very satisfactory, and resulted in safe pressure vessels. You may fairly ask if I would allow such bad practices in regular work, and I would reply without hesitation that I would not subscribe to any such conditions at all, because it is cheaper in a properly equipped shop to do the work right than to do it as these tanks were done. This is aside from any question of safety, or of good work, which are always paramount. How many of the precautions noted above should be taken in any case, depends on the conditions under which the tanks would be used, and so cannot be generally specified. It seems clear that the proposed method of using low-tensile-strength plate, high-strength welding wire, both of proper quality, with other precautions as may be needed, will result in uniformly safe work.

Using Exhaust Energy in Reciprocating Engines

By J. STUMPF,[1] CHARLOTTENBURG, GERMANY, AND C. C. TRUMP,[2] SYRACUSE, N. Y.

There are a surprising number of cases where oil, gas or steam engines will show better economy than purchased power and electric motors, and this may be emphasized where the exhaust from steam engines is valuable for heating or process work. Up to now, reciprocating engines have suffered from losses due to incomplete expansion. There has been a compromise between such losses and mechanical ones connected with the use of very large cylinders. Oil engines, multiple-expansion and uniflow steam engines are coming to use high ratios of expansion, and these are doing much to reduce exhaust losses. Many advantages may be gained, however, if the energy remaining in the exhaust at release can be converted into kinetic energy, and from that into partial vacuum in the cylinder.

The theoretical problems are presented in this paper for discussion, and practical applications to either single-cylinder or multi-cylinder engines are suggested and illustrated.

WITH the rising prices for fuels in this country, anything which may result in fuel economy through turning more heat into useful work should be of interest.

The use of kinetic energy in long exhaust pipes has often been attempted in a practical way to the writers' knowledge in gas, gasoline and oil engines, especially of the two-stroke-cycle type, to improve the scavenging effect and increase the power output. Successful results were usually obtained more from a method of trial and error than from any attempt at design, or the use of nozzles, diffusers, etc., which might avoid losses and improve the effect.

Similar long pipes have been used on the suction side of air compressors, and on the discharge of pumps, to improve the volumetric efficiency. Whether conscious attempts have been made to produce such effects in ordinary steam engines, which usually have exhaust-valve passages too tortuous to avoid serious losses, will no doubt be brought out in discussion. It is probable that the studied application of suitable exhaust pipes with properly designed nozzles for gas and steam engines, especially those with piston-controlled exhaust ports, is new, for a United States patent has just been allowed on it.

In Fig. 1 is shown a conventional indicator card from a steam engine, with the loss due to incomplete expansion represented by the shaded area *D*. It will be noted that this area is large as compared with the small part of it due to opening the exhaust ports,

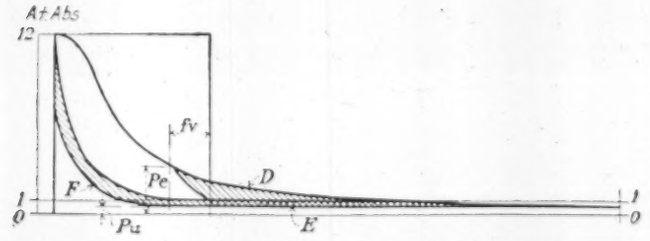

FIG. 1 CONVENTIONAL STEAM-ENGINE INDICATOR CARD SHOWING EXHAUST ENERGY

or valves, considerably in advance of the end of the stroke. If the energy represented by *D*, plus that due to expansion to a lower final pressure such as the area *E*, can be converted into partial vacuum, it will obviously be transferred, or at least all of it but the losses, to the compression side of the card as useful work, represented by the area *F*. This would have the effect, evidently, of reducing the back pressure in the cylinder of the engine, and therefore the final compression pressure by a greater amount the more energy there is available at release.

The several diagrams in Fig. 2 show how the loss due to incomplete expansion would increase with longer cut-off and higher release pressures. They also indicate how these losses may be turned into gains in useful work by reduction of back pressure and compression. The cards are all drawn for exhaust to atmospheric pressure and the pressure scale is in atmospheres. They indicate that any method of transferring energy into partial vacuum must be able to take care of variable loads. They do not indicate any relations between the time of exhaust opening and the velocities

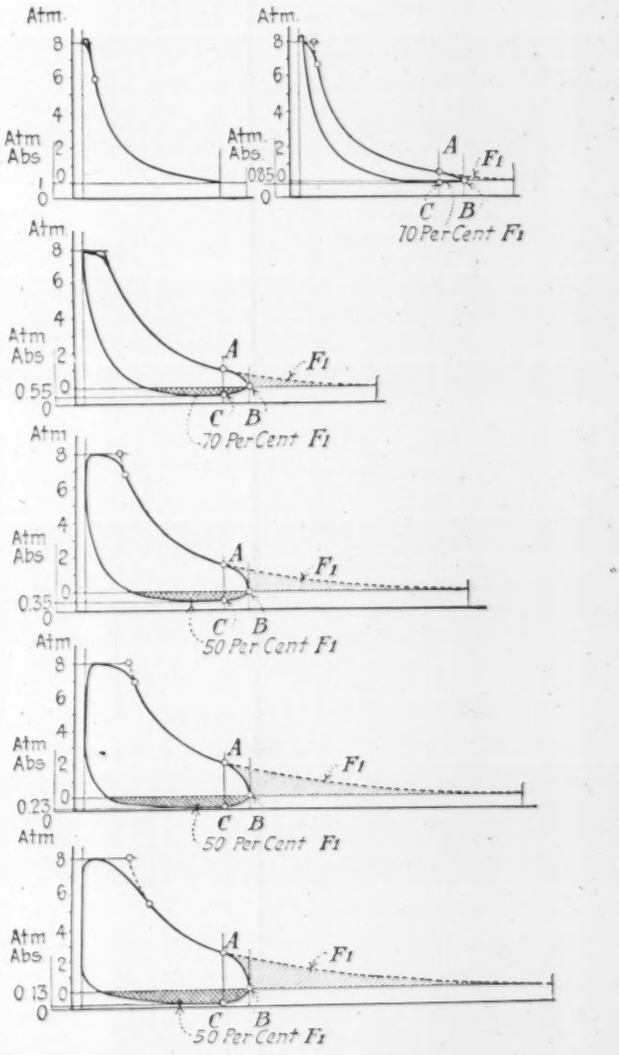

FIG. 2 CUT-OFF AND RELEASE PRESSURE EFFECTS ON INCOMPLETE EXPANSION LOSS

used in the exhaust pipes. These would have to be shown in a different kind of diagram, based on energy rather than pressures. The problem is somewhat similar to those met in ballistics, or in the design of Humphrey gas-pumping engines, in which kinetic energies of solid and elastic bodies have to be figured with respect to time and distance. The number of variables is so many, that graphic rather than numerical methods of computation are to be recommended.

LONG EXHAUST PIPE IN PRACTICE

In order to give an idea of the practical application of a long exhaust pipe, for the above purpose, a uniflow steam cylinder with a number of exhaust nozzles and a long pipe is shown in Fig. 3. The nozzle in the cylinder is difficult to design for best efficiency because it is opened relatively slowly by the piston near the end of its stroke. The other end of the pipe should have some kind

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[2] Vice-Pres., Humphrey Gas Pump Co. and Stumpf Una-flow Engine Co.

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of diffuser for reducing velocity energy to pressure energy, and this is also not easy to design. The action of the pipe itself would seem to depend upon the following several variable factors:

a The speed of the engine and number of exhaust puffs per minute.
b The variation of pressure at and after release at the cylinder.
c The variation of pressure at the other end of the pipe.
d The area of the nozzles and exhaust pipe.
e The length of the pipe.

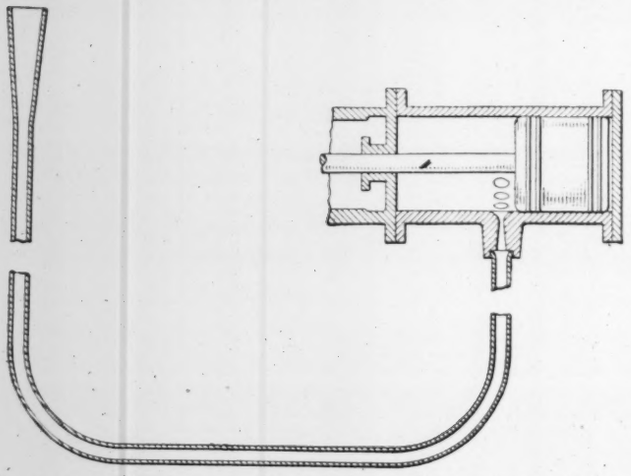

FIG. 3 EXHAUST NOZZLE AND LONG PIPE OF UNIFLOW STEAM CYLINDER

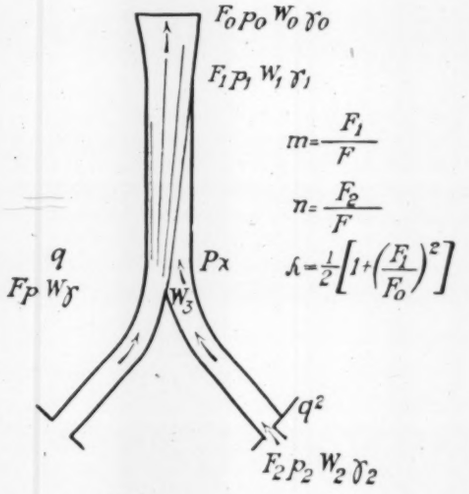

FIG. 6 TWIN-NOZZLE DESIGN FOR HIGH-SPEED MULTIPLE-CYLINDER ENGINE

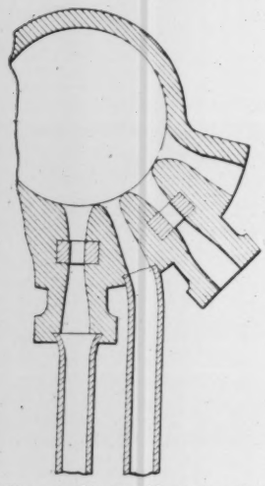

FIG. 4 EXTRA NOZZLES AND EXHAUST PIPES FOR REGULATION UNDER LOAD VARIATION

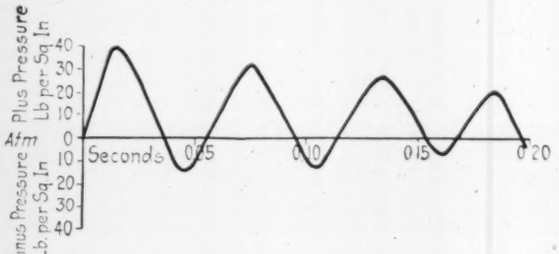

FIG. 5 PROBABLE VIBRATION OF MEDIUM IN EXHAUST PIPE OF SINGLE-CYLINDER ENGINE

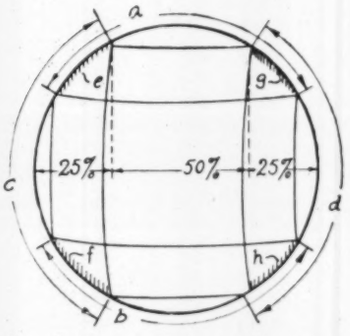

FIG. 7 OVERLAPPING OF EXHAUSTS FOR TWO-CYLINDER DOUBLE-ACTING ENGINE

f The duration of the exhaust period till closing of ports.
g The compression and expansion of the steam or gas itself.
h Heating due to friction.
i Cooling due to outside temperature conditions.

It may have been the experience of many, as it has been of the writers, that a pipe of this kind, subject to sudden puffs, will cause the steam or gas in it to pulsate. It is sometimes evident in cards taken with sensitive indicator springs. Its length and volume relations may be likened to those of an organ pipe. The difference may be pointed out that the pressure changes and velocities may be higher in this case, and vibrations much slower and longer are desirable than would be the case in the production of sound waves, which are to be avoided with exhaust pipes. It is evident, however, that the slower the speed of the engine the longer must be the pipe.

PROVISIONS FOR LOAD VARIATION

For engines running at moderate and nearly constant speed, the pipe length may be fixed and the area designed to give the best suction effect at the most desirable load. Variation of load can be provided for, as shown in Fig. 4, with extra nozzles and exhaust pipes which may be thrown in or out of action by the engine-governing system. Another method would be to provide an exhaust pipe in the form of a coil, with valves which would change connection between cylinder nozzles and diffuser so as to vary the length of the pipe. This might be necessary with variable speed engines.

With single-cylinder engines the length of exhaust pipe necessary to produce the maximum suction effect may be too great for practical uses. As with a musical instrument, however, each vibration of the medium in the pipe may have its harmonic; or at least will be followed by other pulsations of reduced amplitude. If the second or third pulsation is caught at its lowest pressure as the exhaust ports close instead of the first, the pipe will have to be only one half or one third as long, respectively. The effect of friction losses and cooling may change the exact length, but the result may be in favor of the shorter pipe. Fig. 5 illustrates the kind of a vibration which may be expected.

Calculations for the proper length of exhaust pipes involve so many variables that it is probably easier to choose a reasonable size of pipe and arrange the cylinder with approximately the proper nozzles, then cut and try with different lengths of pipe and with a sensitive spring indicator on the engine until the best length is found. It may be interesting to suggest the use of graphical curves of pressure-volume, energy-volume, and energy-time as a means of arriving at the approximate design with which to start experiments.

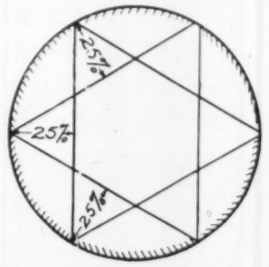

FIG. 8 GAIN IN OVERLAPPING WITH THREE-CYLINDER DOUBLE-ACTING ENGINE

OVERLAPPING EXHAUSTS

For multiple-cylinder engines, especially those which run at high speed, the periods of exhaust will overlap, and by proper design of nozzles one exhaust may be made to draw on the other. Such a twin-nozzle design is indicated in Fig. 6, which is that on which the work with a two-cylinder locomotive has been based. The overlapping of the exhausts for such a two-cylinder double-acting engine is shown in Fig. 7. The gain in overlapping with a three-cylinder, double-acting engine is shown in Fig. 8.

It is evident from these two diagrams that with four exhaust puffs per revolution, or less, it is necessary to take account of the

vibratory action of the exhaust pipe. Its length and volume and the cooling and friction loss must be fixed either by calculation or by experiment, or in combination. With six or more exhaust puffs per revolution the suction effect may be almost entirely produced by ejector nozzles, so paired as to coöperate and induce partial vacuum in each cylinder at the instant when the exhaust port is closed, at the beginning of compression. Even in this case it may be necessary to proportion the exhaust pipes, in length and volume, so that adverse vibrations may not be set up to spoil the vacuum.

Single-acting engines of four cylinders and less will evidently require longer exhaust pipes than those of six cylinders and more. The higher speeds at which these engines are usually run will tend to reduce the necessary pipe length. All the benefits of the exhaust-ejector action accrue to single-acting engines, except that when the pistons control the exhaust ports they cannot be made shorter, as will be explained later, with respect to this advantage, in double-acting uniflow engines.

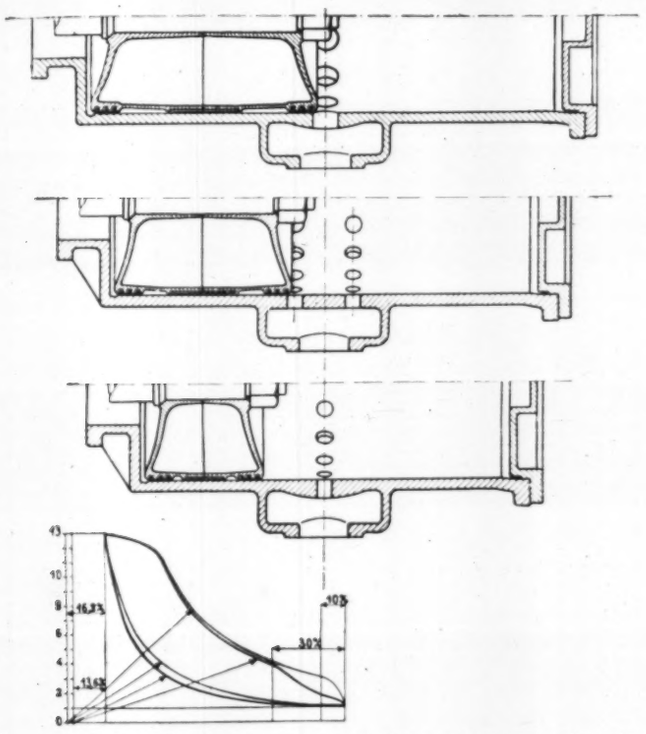

FIG. 9 AREA MODIFICATION AND LOCATION REARRANGEMENT TO SHORTEN PISTON AND CYLINDER OF DOUBLE-ACTING ENGINE

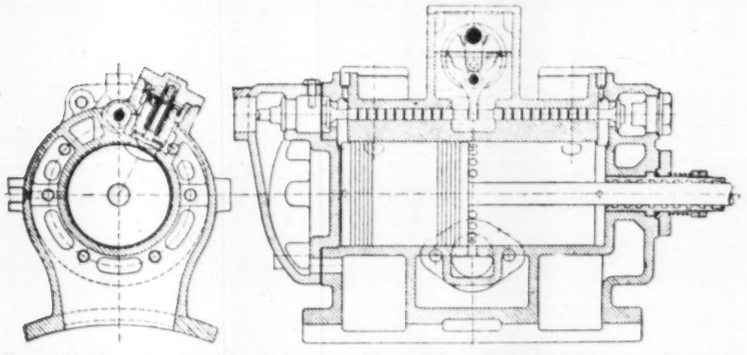

FIG. 11 ORIGINAL CYLINDER DESIGN WITH LONG PISTON, NUMEROUS EXHAUST PORTS, LARGE EXHAUST BELT AND NECESSARY COMPRESSION-RELIEF VALVES

Ordinary counterflow steam engines with exhaust valves, or with a single valve for admission and exhaust, not only would be difficult to arrange with suitable nozzles to avoid eddy losses, but the exhaust period is usually made too long to be covered by the larger pulsations of the long pipe, or the ejector effect of other nozzles. A cylinder with exhaust ports, like a two-stroke-cycle gas engine or a uniflow steam engine, can be provided with almost unlimited exhaust port area and the exhaust period can be controlled—to be long for high speeds, or short for low speeds. The four diagrams in Fig. 9 show how the exhaust ports may be modified as to area, and rearranged as to location, so that, with a double-acting engine, both the piston and cylinder become shorter. For non-condensing work, such as in locomotives, automotive vehicles, and a large proportion of our stationary engines, the number of ports may be reduced to one, two or three, and the exhaust belt of large diameter dispensed with as shown in Fig. 10. The smaller nozzles in this illustration are provided for bleeding steam, after it has done useful work, for heating cars, or feedwater. Such nozzles may also be used for supplying steam for process work, or for heating, with a small part of the exhaust from stationary engines. The long exhaust pipe and ejector action may also be used to reduce the clearance volume required to control compression, or to dispense with exhaust valves, when it is desired to operate the engine with exhaust against back pressure higher than atmospheric, and use all the steam for heating or process work.

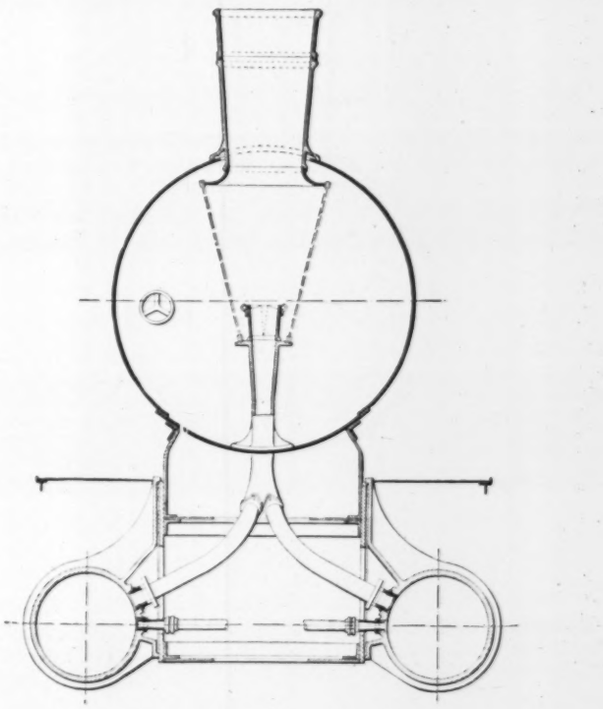

FIG. 10 NUMBER OF EXHAUST PORTS REDUCED AND LARGE-DIAMETER EXHAUST BELT DISPENSED WITH IN NON-CONDENSING ENGINE

COMPARISON OF CYLINDER DESIGNS

The practical advantages of reducing the exhaust orifices to two long slots are well illustrated by comparison between Figs. 11 and 12. Fig. 11 shows the original design of cylinder for a portable engine and boiler for farm or well-driller use. The long piston, large number of exhaust ports, large exhaust belt, and the necessity for compression-relief valves, are evident. In Fig. 12, however, the piston and cylinder have been shortened considerably, the piston over 25 per cent, and the cylinder nearly 20 per cent. The exhaust ports and belt have been reduced to two nozzles, and the cylinder support has been simplified and moved to one end only. Compression-relief valves have been dispensed with, except for small drain cocks for starting a cold engine. The long exhaust pipes are shown leading to the smokepipe, in Fig. 13. Experience with the locomotive has shown a more uniform draft is induced than was the case with the sudden puffs of the ordinary exhaust-pipe arrangement. The pipe which is shown leading out of the diffuser in the smoke-stack is evidently provided to take off steam for heating feed-water.

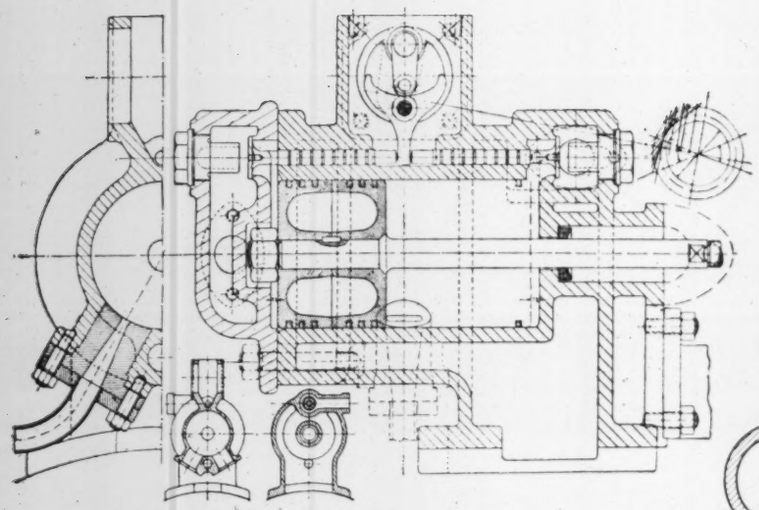

FIG. 12 NEW DESIGN WITH SHORTER PISTON AND CYLINDER, TWO NOZZLES AND NO COMPRESSION VALVES

NOZZLE ARRANGEMENT

In multi-cylinder engines several different arrangements of exhaust pipes and nozzles suggest themselves. Perhaps the simplest is that often seen in gasoline-automobile-engine exhaust pipes, which may be called a series arrangement as shown in Fig. 14. This may have the disadvantage that the cylinders farthest apart should benefit by overlapping periods of exhaust, whereas the several nozzles between the end cylinders are likely to interfere with friction losses. Bringing a loop of exhaust pipe back behind the first nozzle, as shown dotted in the diagram, might improve this arrangement, if proper length is used.

Another disposition of nozzles is shown in Fig. 15. This may be called an arrangement in pairs, or in parallel. The pairs of cylinders which have the longest overlapping of exhaust, because of their crank-throw relations, should be connected to the same exhaust nozzles. The common discharge from these paired nozzles should then be connected in other pairs, finally to discharge through a common exhaust pipe and diffuser.

If it is desired to take off exhaust steam at a pressure above that of the atmosphere, the exhaust-pipe diffuser must be made part of a large receiver tank, from which a small pipe or pipes may lead steam to the heating system at nearly constant pressure. The volume of such a receiver must be large, or the changes of pressure in it will have too great a damping effect on the exhaust-pipe pulsations. It makes design by calculation still more difficult.

The practical application of long exhaust pipes, receivers, nozzles, etc., is by no means so difficult as their proper design. Experience with Humphrey pumping engines of all types and sizes has shown that the inertia effect of long pipes may be a decided detriment to efficiency in some cases, but may be turned to decided advantage if properly utilized and controlled. One of the writers has seen the capacity of these internal-combustion engines improved 50 per cent by simply changing the length of exhaust pipe. Fortunately the graphical methods of design developed for Humphrey pumping engines may be easily adapted to new uses. Ways must be found to take account of more variable factors (nine or ten in this case); but that is easier by graphical than by any other method. It may, however, take some time and experimental work to determine the practical coefficients.

Long exhaust pipes and proper nozzles, however, do provide a means of controlling compression, which in a uniflow engine serves to improve thermal conditions, as well as mechanical cushioning, for which it is mostly used in ordinary steam engines. They avoid large clearances in non-condensing engines, or the alternative of mechanically operated exhaust valves, which the condensing uniflow engine has already dispensed with. The writers of this paper will welcome a broad discussion of the subject.

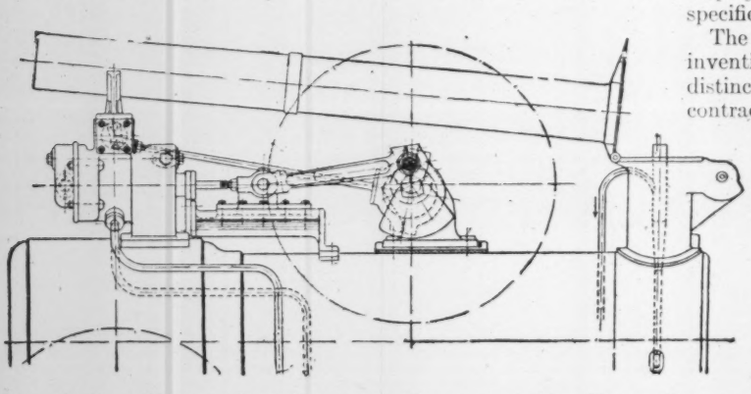

FIG. 13 LONG EXHAUST PIPES LEADING TO SMOKEPIPE IN NEW-DESIGN CYLINDER

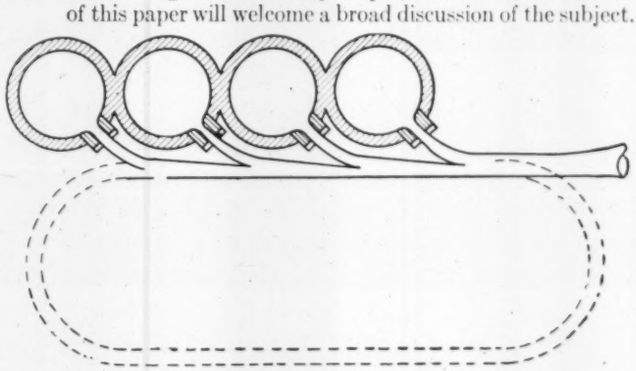

FIG. 14 SERIES ARRANGEMENT OF EXHAUST PIPES AND NOZZLES IN MULTI-CYLINDER ENGINE

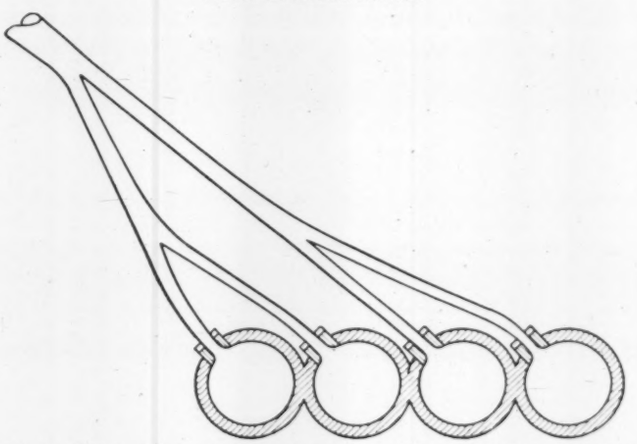

FIG. 15 PAIR OR PARALLEL ARRANGEMENT OF NOZZLES IN MULTI-CYLINDER ENGINE

In a letter to the *Iron Age* (May 11, 1922, p. 1299), G. H. Benjamin cites several decisions of the Federal Courts to the effect that an employer has no right to a patent for an invention made by an employee in the absence of an express contract or agreement for the specific employment to make an invention.

The general principle employed is that if an employer made an invention after he entered the service and the invention was not distinctly specified and included within the terms of contract, the contract does not extend to such invention.

The rule followed by many corporations in making contracts with employees is to specify so much for their services in the line of their specialty and so much for any inventions that they make during the time of their employment. If such special compensation was not specified the employer has no right to the invention of the employee.

Unless the invention has been distinctly specified in the contract of employment it is accepted that the contract does not extend to the invention, as the invention was not "in being" or contemplated at the time the contract was signed and therefore was not within the terms of the contract or covered by the compensation.

Burning Bituminous Coal on Stokers

Importance of Keeping a Bituminous-Coal Fire Agitated—Coal Analyses and the Danger of a Low-Fusing Ash—Typical Stoker Installations and the Best Methods of Operating Them

AT THE Joint Fuel Conference held by the New Haven Branch of the Connecticut Section of the A.S.M.E., the New Haven Chamber of Commerce, and local sections of other engineering societies on November 14, 1921, of the five papers presented three bore on stoker operation with soft coal, namely: two entitled Burning Bituminous Coal on Taylor Stokers, by G. E. Wood, of the Connecticut Company, New Haven, and O. J. Richmond, of the United Illuminating Company, Bridgeport, Conn.; and Burning Bituminous Coal on Type E Stokers, by R. A. Sanders, of the Seamless Rubber Company, New Haven.

Among other things these papers point out those items of a coal analysis that, if not held within proper limits, will cause trouble. When operating at above 150 per cent of rated capacity it is most important that the coal should have a "high-fusing" ash; that is, the ash should not melt under 2400 deg. fahr. Where this precaution has not been observed the operation of the stoker has been seriously interfered with. Valuable hints on obtaining the best results from these two types of stokers are also included.

BURNING BITUMINOUS COAL ON TAYLOR STOKERS

By G. E. WOOD,[1] NEW HAVEN, CONN.

THE Taylor stoker is representative of the underfeed type which introduces the fuel into the furnace from beneath the fuel bed. The fuel is forced in by the action of rams and in this manner the whole fuel bed is kept agitated. As we all know, this is of vital importance to the successful combustion of bituminous coal, for in the initial stages of combustion this coal tends to soften, coke and run together. If it is left in a quiescent state it will solidify into a homogeneous mass that is highly resistant to the passage of air at ordinary pressures. It is due, therefore, to this agitating action that the underfeed stoker has been successful.

In operating a Taylor stoker it is fundamentally important to maintain a uniform speed so as to free the grates of the ash as it is formed. This condition willl insure clean fires. If the ash is allowed to accumulate, it is forced up into the fire, the inevitable result being clinker formation. In addition to uniform speed, care should be exercised in operating the lower rams and the extension grates. The long stroke should be used on the former to prevent the fire from piling too high and falling over on to the dump plates—the latter just before dumping to break up clinker, and after dumping to cover the grates and prevent air leakage. The thickness of fire depends on the load, but the contour should be maintained standard at all loads, i.e., high on the upper portion of the grates and sloping gradually off to the dump plates.

Under normal conditions it has been found that good results are obtained by leaving the air damper to the extension grates open at all times. The speed of the stoker and the plenum in the wind box best suited for various ratings are approximately as follows:

Rating, per cent	Stoker speed, time per rev.	Wind-box pressure, in. of water
100	3 min. 54 sec.	1.0
150	2 min. 38 sec.	2.25
200	2 min. 5 sec.	2.90
250	1 min. 35 sec.	3.80

These figures do not hold in all cases and should be checked by flue-gas analyses. They are of value, however, in that they give a close approximation of what the conditions should be.

The difference in the performance of coal of different analyses at an average rating of 150 per cent may be seen from Table 1 in the next column.

[1] Supervisor of Power Plants, The Connecticut Company, New Haven, Conn. Mem. Am.Soc.M.E.

In the case of Sample A the speed of the stoker and the air pressure agree closely with the figures previously given, the speed being somewhat higher and the air pressure a trifle lower. No trouble was experienced from moderate clinker formations because they were small. Under 250 per cent of rating the results were equally satisfactory.

With Sample B, during the test considerable trouble was encountered from large clinkers forming on the tuyeres and freezing on the side walls, extension grates and bridge wall. This condition accounts for the long time required to dump. Holes in the fire were numerous on account of the clinker pulling the coke down. These holes were filled as best they could be by using the long stroke for the lower part of the grate and a hoe for the upper sections.

At 250 per cent of rating, clinkers formed so rapidly that they could not be kept moving. The shear pins let go and the stoker was put out of commission after 1½ hours' run. At the end of the first hour it was necessary to dump and it required the combined efforts of 3 men for 45 minutes to accomplish this process. The coal was practically useless under forced firing.

TABLE 1 PERFORMANCE OF TWO DIFFERENT COALS AT AN AVERAGE RATING OF 150 PER CENT

	Sample A	Sample B
Moisture, per cent	4.8	3.4
Volatile matter, per cent	22.1	32.6
Fixed carbon, per cent	66.6	53.8
Ash, per cent	6.5	10.2
B.t.u. per lb. as fired	13,774.0	13,103.0
Sulphur, per cent	under 1	2.25
Rate of combustion, lb. per hr. per sq. ft. of grate	33.0	34.0
Refuse, per cent	9.5	16.3
Combustible in refuse, per cent	30.0	38.0
CO_2, first pass	12.9	13.8
CO_2, flue	11.8	12.8
Average speed of stoker, time per rev.	2 min. 13 sec.	2 min. 36 sec.
Average pressure in wind box, in. water	2.46	2.20
Time between dumps	3 hr.	2 hr.
Time required to dump	2 min.	20 min.
Combined efficiency, per cent	75.8	74.8

From the two examples cited the vastly different results obtained with coals varying but 4 per cent in ash, 10 per cent in volatile matter and 1¾ per cent in sulphur are evident. The ratio of refuse to coal fired increased, and the percentage of combustible in the refuse increased on account of the clinker formation. Nothing could be done to prevent this formation of clinker, but the "freezing" to the side and bridge walls can be alleviated. To accomplish this, many operators have employed the form of furnace construction which allows the air from the wind box to circulate through the setting walls so as to maintain a flow of air between the walls and the fire. Others use a steam jet instead of air, and in some instances both are used. Either method is effective and greatly facilitates the burning of badly clinkering coals.

Not only does the proportion of ash have a direct bearing on economy, but the temperature at which the ash fuses is an important factor. Tests have been made that show that the efficiency follows the ash-fusing temperature. From these tests it has been concluded that all ash fusing below 2400 deg. fahr. should be classed as low-fusing, and all above as high-fusing.

While it is possible to burn a coal with low-fusing ash under normal loads, it is difficult if not impossible to do so under heavy overloads. The ash invariably melts and runs into the air spaces in the tuyeres, shutting off the air supply. It also bends a crank or breaks a bearing bracket if the shear pin fails to shear. The only solution is to burn the fire down, take the boiler out of service, and send a man into the furnace to break the clinker out.

From these observations the following conclusions may be deduced:

a A good grade of coal with low ash, volatile and sulphur content can be burned efficiently with no trouble and moderate loss of combustible in the refuse;

b As the ash, sulphur and volatile content increase, trouble occurs and the avoidable loss of combustile in the refuse increases.

BURNING BITUMINOUS COAL ON TAYLOR STOKERS

By O. J. RICHMOND,[1] BRIDGEPORT, CONN.

THE Taylor stoker utilizes the gas-producer principle. Green coal is fed by the rams to the lower strata of the fuel bed and is gradually pushed up toward the upper layer and coked, at this time giving off most of its volatile elements which have to pass through the incandescent zone. The coal works upward still farther and it becomes incandescent by the time it reaches the top layer. The grates are sloping, and as the coal gradually burns to ash, it works downward toward the refuse dump where it is discharged by the dumping process to the ashpit. These stokers are very flexible and well adapted to sudden overloads, since in a very few minutes they can run a fire from a banked to an overload condition. They employ forced draft at normal rating, from 1½ to 2 in. of air pressure being used when 30 to 40 lb. of coal are burned per hour per sq. ft. of grate; 3 in. to 4 in. is used for higher ratings, and it is possible to burn 60 to 80 lb. per sq. ft. per hour for short peaks.

The plant whose operation the author has been asked to discuss consists of 18 B. & W. boilers each rated at 600 hp. by the builders. They have 294 4-in. tubes 18 ft. long and 6000 sq. ft. of heating surface. The pressure carried is 200 lb. gage. The stokers are of the Taylor type, 7 retorts wide, 8½ ft. deep, and hand-dumped. The grate area is 95 sq. ft. Distance from stoker to lower row of tubes is 7 ft.

Draft is supplied by nine American Blower Co. fans of the high-speed type, all driven by Terry turbines. These blowers discharge into a common main air duct for all boilers. The air is carried from this main duct by small steel ducts to the stoker forced-draft damper. Regulation of blower is by steam pressure acting through an individual Mason regulator for each fan set.

The coal used is R.O.M. bituminous, a typical analysis of it being: moisture, 1.58 per cent; volatile, 21.40 per cent; fixed carbon, 71.37 per cent; ash, 5.65 per cent; B.t.u., 14,464 per lb. dry; sulphur, 1.06 per cent.

Coal is run from the bunker by gravity to the electrically driven weigh lorry cars. After being weighed it is fed directly through the lorry car chute to the stoker hopper.

The boilers are run from 125 per cent to 150 per cent of rating. This policy was determined by running different numbers of boilers for given loads on the station. It was found by trial that when the boilers were run above 140 to 150 per cent the efficiency dropped off. The apparatus which automatically speeds up the stoker with any increase of air pressure, and thereby tends to keep the proportion of air and coal constant, does not work satisfactorily. While it is admitted that for any given set of conditions, kind of fuel, construction of furnace and method of stoking, a definite volume of air will consume a definite weight of fuel, in practice this does not hold because the fuel varies. In the new Steel Point Station the regulation has been modified by the addition of the Keelhaltz regulator, manufactured by the A. E. Co., and every assurance has been given that this device will regulate satisfactorily even with variation of fuel.

Standard practice is to maintain as nearly constant an air pressure as possible for a given load. From 2 in. to 2½ in. is used under fires and from 0.1 to 0.2 in. suction or negative draft over them. This suction over fires is kept at that point by the so-called balanced-draft regulators. These have been found to work very nicely with a minimum of upkeep, and help materially in keeping stack losses down. Fires are maintained from 20 in. to 30 in. thick, depending on the coal. For all ordinary coals 26 in. to 30 in. of fire and 2½ in. air blast are used. With inferior grades it has been found that the Taylor stoker handles large clinkers readily, and they work down to the dump with little trouble. The clinker that makes trouble is the thin, soft, pasty variety that with some coals runs at times like hot tar on to grates and tuyeres, and even into tuyere air inlets, getting a firm grip and shutting off the air supply in such a way as to result in burned tuyeres. The only way to handle such coal is to run thinner fires and more air in proportion to coal burned, naturally at the expense of efficiency, but keeping the plant running.

Fires are banked by shutting off the air supply and pumping coal enough in to keep the fire away from the grates. Stokers with banked fires are turned over a few times every 2 to 4 hours to prevent so-called "freezing." This occurs when the coal cokes so hard in the bank that it is difficult for the stoker rams to break it up. Every other night boilers are cleaned of what clinkers are adhering to the side walls which are steel mixture blocks.

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BURNING BITUMINOUS COAL ON TYPE E STOKERS

By R. A. SANDERS,[1] NEW HAVEN, CONN.

AT THE Seamless Rubber Company, steam is produced for heating and curing in the production of rubber goods and for operating boiler auxiliaries. Power to drive the machinery is purchased from the United Illuminating Co.

The boiler plant consists of four Babcock & Wilcox water-tube boilers of 393 rated hp. each, equipped with Foster superheaters each with a guaranteed performance of heating 19,788 lb. of steam from 150 lb. gage pressure and 1 per cent of water to 466 deg. fahr. or 100 deg. superheat. Feedwater is heated in a Cochrane open feedwater heater, equipped with a V-notch recording, indicating and integrating meter and forced into the boilers by two three-stage turbine-driven pumps. The output of the boilers is measured by G. E. indicating steam-flow meters on each boiler and an integrating meter on the main steam line to the factory. Flue-gas temperature is measured by a Brown recording thermometer on each boiler showing the temperature at the damper. Another Brown meter is used to record the temperature of the feedwater as it leaves the pumps.

Two No. 6½ Buffalo conoidal fans, each capable of delivering 40,000 cu. ft. of air per min. against 6 in. water static pressure, furnish the forced draft necessary to operate the boilers. With maximum delivery the speed is 1260 r.p.m. Under the usual operating conditions, the pressure under the fire being 3 in., the speed is about 1030 r.p.m., the horse power 24½, and one fan serves two boilers at 100 per cent rating.

Each boiler is equipped with a type E single-retort stoker made by the Combustion Engineering Co. These stokers are guaranteed to hold the steam pressure within 5 lb. of the specified pressure when the boilers are operated up to 200 per cent of normal rating and to give a combined boiler and furnace efficiency of 75 per cent when the boilers are operated between 100 per cent and 200 per cent of normal rating, the draft in the furnace not to exceed 0.15 in. at 200 per cent rating and to operate under conditions specified and at the same time conform to the smoke laws or regulations of the city of New Haven.

Bituminous run of mine coal is received in hopper-bottom cars and dumped directly into a truck hopper, passing then to a crusher, the capacity of which is 20 tons per hour, which reduces it from a maximum of 10-in. cubes to 2-in., the average being 1-in. A 15-hp. squirrel cage motor provided with remote control operates the coal crusher.

It is then carried by a bucket conveyor, driven by a 7½-hp. induction motor, also remote-controlled, into the overhead bin in the power house. This bin holds about 120 tons and is provided with a belt conveyor which distributes the coal the length of the bin as required.

Four automatic recording coal scales are provided, which weigh the coal as it is fed into the spouts feeding the stoker hoppers. The motors driving the feeding mechanism of the scales are controlled from the boiler-room floor.

Motors driving the crushing, elevating, and distributing machinery are controlled from several points, as a precaution against injury to the installation.

Actual daily evaporation from feedwater which averages 210 deg. to 130 lb. gage, averages about 10.8 lb. of water per lb. of coal burned. No figures are available as to the amount of superheat in the steam, but it is estimated that it is about 50 deg.

(Continued on page 381)

[1] The Seamless Rubber Company, New Haven, Conn.

Weaving Machinery

Weaving Styles and Kinds of Fabrics Produced—Details of Methods Employed—Functions of Special Machine Devices—Different Types of Looms

By L. B. JENCKES,[1] WORCESTER, MASS.

THE process of weaving consists of interlacing two or more series of fibrous materials or threads at right angles or nearly so, so that they will form a fabric. The threads running lengthwise of the cloth are called the warp or "woof," and those running crosswise of the goods are called the weft or filling.

Weaving does not include all fabrics and must be distinguished from those which are felted or plaited, and from netted lace fabric and knitted goods.

A felted fabric is made by bringing masses of loose fibers such as wool or hair together under the influence of heat, pressure, moisture and friction, under which conditions they become firmly interlaced in every direction and form a hard and serviceable fabric.

Plaited fabrics are composed of one set of threads interlaced, but not at right angles. A flat shoelace is an example of plaited fabric.

In netted goods the threads are held in place by knots where they cross each other.

Knitted fabrics are composed of one or more threads held together by loops, making a very elastic fabric, similar to the common Jersey cloth.

Laces are made by passing one set of threads around small groups of threads of a second set instead of passing them from side to side.

With these fabrics we have nothing to do as we are to consider only weaving.

Modern Process of Weaving

The process of weaving in a very general way is this. The warps are wound in a parallel manner on a roll or beam at the back of the loom; the roll being carried in gudgeons and held by friction from allowing the warp to run off too easily. The warp usually passes over two rods called "lease rods" and then through an eye in the center of a wire or cord called a "heddle." The heddles are attached at the top and bottom to a number of harness frames or "healds," being attached to different frames according to the pattern to be woven. Thus the threads can be separated into two planes or sheds forming an opening between, which allows a shuttle carrying the filling or weft to be passed between them. After the weft is passed a batten or lay carrying a reed is drawn forward, forcing or beating up a strand of filling against the next preceding one. The warp threads are then changed, those in the upper plane passing to the lower one and others taking their place in the upper shed. This forms one cycle and places one thread of filling or one pick in the cloth. The point at which the cloth is formed is called the fell. The edges where the filling returns and repasses into the cloth is called the selvage. After the cloth is formed it is drawn forward and wound onto a roll by the take-up.

Ancient Art

The art of weaving is a very ancient one. Very soon after the first inhabitants appeared on the earth they tired of using skins alone, and by interlacing fibrous material, grasses, strips of skin, etc., began to form woven fabrics. The spinning or twisting of fibers into threads was soon discovered and gave great impetus to the art of weaving. Colored threads and material of various lusters and characters were used; soft warm material for the cold climates, and lighter for warm ones, until now every kind of material that is known is woven into a fabric—wool, hair, flax, paper, grasses, metal and almost everything else. Woven fabrics are very largely used, not only for clothing but for manufacturing equipment such as belts, packings, conveying belts, filter cloths, and other products.

The ancient tribes of the East probably contrived the first loom very early in the history of the world. They hung a beam or stick in a tree or from some overhead support and from it suspended the series of warp threads. These warp threads were hung to another beam or log at the lower end. These warp threads were separated into two planes by means of a flat swordlike implement, the sword being given a quarter turn to separate the warps so that a shuttle carrying the weft could be passed. The implement was then drawn downward sharply, beating the line of filling against the preceding one, and the cloth was formed. The sword was then withdrawn and reinserted, separating the warp into different sets of threads, and the process was repeated. Probably in the first weaving, reeds and grass were largely used for the filling. This process was also used by the Egyptians and Greeks. The ancient tribes of India are believed to have laid the warp horizontally and fastened it to a beam, and used a crude heddle frame and heddles suspended from overhead, separating the warp into the two sheds, and also to have had a batten or lay swung from overhead to beat up the cloth. After passing the shuttle a few times back and forth the lay or batten was drawn forward and the cloth beaten into place.

The Chinese were the first to weave to any great extent. They are said to have cultivated silk long before the Christian era, and were weaving intricate designs such as dragons, flowers, fruits and other patterns which would be elaborate even today and this was 200 B.C. While they were doing this the Egyptians and other races of the Near East were only just learning about silk—their experience in shuttle weaving having been limited to spun wool and flax—the ornamentation being almost entirely done by embroidering or darning. Far the greater part of the material woven was plain.

So far nothing has been said about the variation of color in the cloth. Cloth is colored in various ways. It may be dyed in the piece after it is woven, in which case it must all be practically the same color. The yarn may be dyed before it is woven, and woven in patterns, in which case the patterns are nearly all geometric in style. A pattern may be printed on the goods after they are woven, in which case it may be as elaborate as desired. The warp threads may be printed with a pattern before they are woven, that is, each thread may be of various colors throughout its length so that when woven the cloth will present a pattern.

Styles of Weaving

Almost all the different styles of weaving or interlacing of threads may be divided into four classes: First, single cloth—that is, a cloth having one set of warp threads and one set of filling threads only; second, backed or compound cloth having more than one set of warp threads or more than one set of filling threads; third, pile fabric in which a part of the threads are caused to stand on end above the body of the cloth; and fourth, leno cloth where the warp threads are crossed or twisted.

Kinds of Fabrics Woven

Of the single cloths the simplest is that in which the warp threads are divided into two sets only, one-half of the threads being passed through each of two sets of heddles, each set being carried on one heddle frame so that one-half of the warp is in the upper plane each time. Consequently the warp and filling pass over and under each other alternately. If the warp and filling are of equal size the cloth is perfectly plain and square, and it can hardly be told which is the warp and which is the filling. By varying the comparative size of the warp and filling a ribbed effect is produced. If the filling is the largest the ribs run across the goods, and if the warp is the largest the ribs run lengthwise of the goods. Very much of the greater part of all the cloth which is used is formed in this way. It makes muslin, sheeting, and all such common cloths. When colored and sized it makes cambric. When printed with pattern after being woven it forms calico. Gingham is made in

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this way by using warp and filling of various colors. Canvas and duck are of this construction. Taffeta, pongee, and grosgrain silk are all of the same weave as well as the much-used crepe. In crepe the filling is of two kinds, causing the cloth to crinkle. Much of the cloth for men's and women's wear and other purposes is of this formation.

We now come to twill goods. In these the warp is divided into three or more sets and only one-third or one-quarter is brought into the upper shed or on to the face of the goods each pick. All these goods will show a diagonal rib or line on the face, the breadth of the line varying according to the order in which the harness is raised. With warp and filling of the same size the lines will make an angle of 45 deg. with the cloth. If the warp is larger than the filling the angle will be less, and if the filling is larger than the warp it will be greater. By varying the order in which the harness is raised the ribs can be broken and form broken lines, zigzags, diamonds or squares, making a variety of geometric patterns.

Another large class of goods is formed by the satins and sateens. The object in these goods is to present a smooth, patternless surface, and it is accomplished by using a great many very fine threads to form the face of the goods either in the warp or in the filling. For satin the warp is of the fine threads, and forms the face, while for sateen the filling is used for this purpose. In weaving satin from five to twelve harnesses are used, each filling thread appearing on the surface only once in five to twelve picks for about one pick only; the warp being so fine and so close together that the filling pick cannot be detected. In sateen the warp and filling are reversed. The combination of satin and sateen is greatly used in forming the pattern of table damask.

These weaves form almost all the plain cloth, and it is by using a combination of these that an endless variety of cloths is provided, stripes, checks, etc., of various kinds of weaves being combined in the same piece of goods.

It often becomes desirable, however, either for warmth or softness to add weight to a piece of goods without interfering with the pattern, and this is accomplished by using two sets of filling and one set of warp threads, or by using two sets of warp threads and one set of filling. The use of two sets of filling threads usually makes a soft piece of goods as the filling yarn is apt to be of soft character, but it is also the most expensive since it is slow to weave. The face of the goods is woven as before and the face yarn is always kept on the face of the goods, the backing yarn being under it and attached to it by passing just sufficient threads under each backing thread to hold it firmly in place. Sometimes the face and backing yarn are caused to exchange places, forming a pattern on the face, and the reverse of the pattern on the back. This is called reversible goods.

Two complete cloths may be woven and then stitched together by a separate set of threads called binder threads, or by a few threads of each set being woven into the other cloth. This makes a two-ply cloth, and in the case of belting and other cloths for use in manufacturing purposes as many as ten plies or ten separate cloths are woven one above another and stitched together. It is in this way the so-called "bullet-proof" cloth was made. The outside cloth or ply may be of fine material for appearance and the inside may be of a cheaper material for economy, or stronger material to give strength.

A pile fabric is one in which a portion of the yarn is caused to stand erect above the face of the goods. It is woven either single or double. In the double cloth—plush or velvet—two webs of the ground fabric are woven one above the other and a certain distance apart, and the pile warp is passed between the two, being held in each cloth, and later cut, forming two pieces of cloth with pile on the face only. Two shuttles are generally used, and both are thrown on each pick through the two separate sheds, one above the other. The cutting is done by a knife which passes back and forth between the two cloths while they are separated and drawn forward by two take-up rolls. In weaving the single-pile cloth the pile warp is raised above the rest of the warp on each pile pick, a wire is passed through the shed on this pick, and the pile warp is woven over it, the wire being afterward withdrawn. On the end of the wire is a knife which cuts the top of the loop as the wire is withdrawn, forming cut plush or velvet. If the knife is omitted and the end of the wire is pointed only an uncut plush is produced. By combining the cut and uncut plush and omitting the pile altogether, according to a pattern, very beautiful fabrics are produced all in one color. These are very much used for upholstery, both for furniture and for automobiles.

The greater part of all carpet weaves belong in the pile-fabric class: the Brussels carpet which when cut becomes Wilton; the cheaper tapestry and velvet carpet in which the warp is printed before it is woven; the Axminster in which each single tuft is set independently, and in which there is no expensive pile yarn concealed in the goods; and the elegant and costly chenille carpet in which the filling is composed of a narrow woven fabric having a deep fringe on each edge, which when woven into the carpet with the fringe erect forms the pile. The carpet is woven in any shape to fit any room, even circular, and in any width up to thirty feet. In the oriental rugs each tuft is set in separately and is knotted to the warp so that it cannot be pulled out. These rugs are still made almost entirely by hand, although a few looms have been built for this purpose. The Crompton & Knowles Loom Works has built a loom which ties the Persian knot in a rug 9 ft. wide, tying an entire row of knots across the rug at one time, or about 1200 knots.

In the leno fabrics the warp threads cross each other every time the shed is changed and the filling passes. In this way the threads are better held in place in open weaves such as gauze or marquisette. These fabrics are not very widely used.

This is an outline of the various fabrics which are in demand, and for which looms or weaving machines must be built.

EARLY NINETEENTH CENTURY HAND LOOMS

Before taking up the machines in detail it might be well to follow the art of weaving a little farther. Up to about 100 years ago almost all weaving was done by hand looms. These, however, had become very similar in their construction. All were built practically entirely of wood, and consisted of a heavy wooden frame with the warp beam or roll at the back with a friction let-off to prevent the warp from being drawn off too easily. The harness frames were suspended from overhead, and operated by a foot treadle by the weaver. The lay or batten was swung from overhead and carried the reed, and was drawn forward by hand by the weaver after the filling had been passed in order to beat up this filling. The shuttle was thrown by hand from one side and was caught by the hand of the weaver at the opposite selvage. The take-up roll was at the front of the loom, and was turned by the weaver to wind up the cloth after several picks had been woven. This was a very slow and laborious process, but by care and effort very handsome weaves were produced. There are some hand looms in operation today, largely for pleasure or for educational purposes, and a few commercially. There is a sufficient demand for the hand-made weaves by people who are looking for curious and artistic goods so that these looms may be run at a profit, and very handsome bedspreads, table covers and articles of this sort are produced in as elaborate patterns as can be woven on any power loom. A few improvements were made in the hand loom from time to time. The lay or batten was lengthened, and a shuttle box provided to catch the shuttle instead of the weaver catching it by hand, and a picking motion whereby the shuttle was thrown with a stick, actuated by the weaver, was substituted for the throwing of the shuttle by hand. Where a number of colors or shuttles were to be used, several shuttle boxes were arranged so that the weaver could move them by hand into the proper place and throw the shuttle with the picker stick instead of having the shuttles loose and operating them by hand. Almost all the weaving was done in the homes of the weavers. A few crude power looms were built, but they were not largely used. There seemed to be labor troubles even in those days and the weavers would not go into factories, and even destroyed them. Preparatory machinery was very crude, which delayed the production of power looms.

FUNCTIONS OF CERTAIN MACHINE DEVICES

All looms are composed of a number of separate motions, each motion complete in itself, and carried on one frame, and operating at the proper time. All of these are varied greatly according to the character of goods to be woven, the variations being principally as to the weight and strength and the general principles remaining very largely the same. The motions ordinarily used are as follows:

The let-off is a mechanism which carries the beam or spool holding the warp which has been carefully wound upon it in a parallel manner. This let-off allows the warp to be drawn off only as required. Usually a friction drum and band of leather, rope or chain is used to regulate the speed with which the warp is released, but for weaving accurate goods a worm and worm wheel are employed, regulated by the tension upon the warp, thus maintaining the tension somewhat more uniform.

For beating up the cloth or forcing the consecutive picks or rows of filling into place there is the lay which carries the reed. This is usually swung from below near the floor, and is moved forward and back by a crank and connectors. The lay carries on each end the boxes for the shuttles, one on each end when only one kind of filling is to be used; when more than one kind of filling is desired as many as six boxes on each end may be provided. With six boxes on each end usually six kinds of filling are used, although it is possible to use as many as eleven. The use of more than six causes great complication in the pattern for moving the shuttle box.

The shedding motion is used for opening the warp to allow the passage of the shuttle. This motion presents the greatest variety according to the cloth to be woven. Up to five harnesses and where the weave is balanced so that there is always one harness or more moving up and one or more coming down at the same time, a surface cam under the loom and a lever is used to draw the harness down while the corresponding ones are raised by straps and rolls overhead. For more than five, but not more than eight, harnesses a path cam at the end of the loom is usually employed, connections being made to the top of the harness from the top of the cam lever to raise it, and from the bottom of the harness to the lower end of the cam lever to lower it. For each change of pattern in this mechanism an entirely new set of cams is required, and it is necessary to change the cams and possibly the gearing operating them whenever the pattern is changed. When more than eight harnesses are used, and when frequent changes in patterns are to be made, some form of a head motion with a changeable chain or pattern surface which can be readily changed is desirable. The pattern surface is usually composed of a chain or a series of bars linked together, and of such form that the heights of any part of the links or bars can be varied, the height of the link or a portion of the bar indicating the action of the harness. In the so-called Knowles head the chain is composed of a series of round bars, every bar carrying a roll or a riser or ferrule for each harness. The action of the large roll or riser is to raise a vibrating gear into mesh with a toothed cylinder, which revolves the gear one-half turn, and through a series of connectors and levers raises the harness into its upper position. A sinker or a tube causes the gear to mesh with another toothed cylinder, revolving in the reverse direction, and lowers the harness. In a dobby, wooden bars fastened together by links form the chain. The levers which raise the harness are moved by hooks, which are normally hooked on to a reciprocating bar, raising the harness each pick. The pegs in the wooden bars lift the hooks from the bars and cause the harness to remain down or in the lower plane, the pegs being inserted in the wooden bars so as to form a pattern. These heads are made up to a capacity of thirty harnesses and are capable of weaving a pattern of any length up to many hundreds of picks.

The picking motion throws the shuttle across the loom through the shed to lay in place the lines of filling. It is nearly always composed of a quick-acting cam attached to a stick by levers and a connector, the upper end of the stick being behind the shuttle so as to throw the latter across the loom.

The take-up is the mechanism which draws the cloth forward as it is woven and winds it onto a roll at the front of the loom, the roll being given a slow revolving motion by ratchet and pawl or a worm and wormwheel connected to the roll by a train of gearing.

Looms when belt driven are always operated by means of a pulley which can be quickly connected. Formerly a tight and loose pulley was used, but more recently the usual construction is a pulley with a side-friction clutch which will release very quickly, although for the heavier types of looms an internal-expansion clutch is considerably used. The pulley is mounted either on the crank shaft or one parallel to it, and attached to it by gears, or the pulley shaft may be attached to the crankshaft by means of bevel gears and run at right angles to it, according to which ever method is best adapted to the shafting of the mill. At the present time looms are very largely driven by individual motors, in which case it makes no difference at which angle the pulley shaft is placed.

Box-Motion Mechanism

The box motion, so-called, is another important motion. It is the mechanism which determines which shuttle shall be thrown across the goods in a loom where several shuttles are in use. The boxes are moved up and down at each end of the lay, and the one from which the shuttle is to be thrown is positioned level with the shed on each pick. Also the box to receive the shuttle is placed in a similar position at the opposite end of the loom. In looms where only two or three boxes are used and where the number of changes are small, perhaps only three or four and then a repeat, this is accomplished by a simple cam and lever. The color or the box pattern is apt to be very long, longer even than the pattern for the weaving, and for more than a few changes a mechanism with a changeable pattern chain or surface is used. This is quite often very similar to the Knowles head-shedding motion, lifting the boxes in place of the harness, and oftentimes it is composed of a gear with a sliding tooth or a sliding intermittent gear which is moved into mesh by the use of the pattern chain, and turns the gear one-half a revolution, raising or lowering the boxes. For two boxes only one gear or one set of gears in Knowles head is required. For four boxes two sets of this mechanism are required, and they are attached to the boxes by compound levers so that four positions can be obtained, and for six boxes three sets of compound levers are used.

The color patterns are apt to be very long, particularly in the case of towels, blankets, scarfs, etc. Usually each color is used for a number of picks, and the various groups of colors usually can be made multiples of each other. This fact is taken advantage of to reduce the amount of pattern chain required. The mechanism which accomplishes this is called the multiplier. If for instance the common divisor of all the groups of colors is ten picks, a small chain of ten bars is added to the loom, and each revolution of this small chain changes the main chain one link, thus dividing the amount of pattern chain required by ten. Where the pattern runs as far as the middle of the piece of goods and then reverses, as is quite customary in towels and goods of that character, this fact is taken advantage of by reversing the chain for one-half the pattern, thus cutting in half the amount of chain required.

Automatic Stopping Devices

When power looms came into use it became necessary to apply various devices for safety and for stopping the loom in order to prevent damage to the cloth or to the machine in case of a failure to operate correctly. A filling stop motion, so-called, is applied to stop the loom in case of a breakage of the filling or weft in order to prevent a defect in the goods. A warp stop motion is applied which answers the same purpose in the case of breakage in the warp.

A protection is added to the loom which stops it instantly in case the shuttle should fail to pass entirely through the shed. If it remained in the shed and was beaten up against the cloth by means of the lay it would cause serious breakage in the warp, and very likely break the shuttle or some other part of the loom.

In the ordinary looms the weaver is required to remain close enough to the machine so that she will notice when the filling in the shuttle becomes exhausted, and replenish it before it becomes entirely used up, and she is obliged to put each bobbin in the shuttle by hand. This limits to some extent the number of looms which one weaver can operate, and to overcome this and make for greater efficiency the automatic or magazine loom has been developed. This is made suitable for two, four, or six colors, and by means of a so-called filling detector it notes the approaching exhaustion of the filling before it is entirely gone, and replaces the empty filling bobbin or carrier in the shuttle without stopping the loom, selecting the proper color for each shuttle. This enables one weaver to operate as many as sixteen looms, the number depending upon the character of the warp and filling. These looms are of course equipped with warp and filling stop motions, and are so nearly automatic that in many mills where the power is kept in operation during the noon hour the weavers fill the magazines and leave the looms running when they go to dinner, and find many of them in operation when

they return. Some of them will be stopped due to fault in the warp or filling, but without damage to the fabric, and it is only necessary for the weaver to piece up the warp and filling and start them going again.

In heavier and slower-running types of looms another device is frequently used for automatically supplying the loom with filling. This is known as a shuttle changer. In this device the entire shuttle is removed from the loom when the filling is practically exhausted, and a new shuttle with full filling is substituted. This takes place as in the magazine loom while the loom is in operation, and without interrupting its motions in any way. This type of

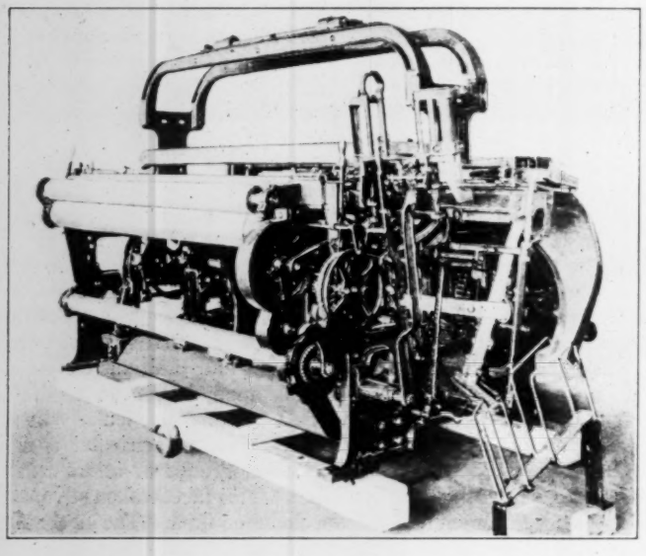


FIG. 1 AUTOMATIC TIRE-FABRIC LOOM

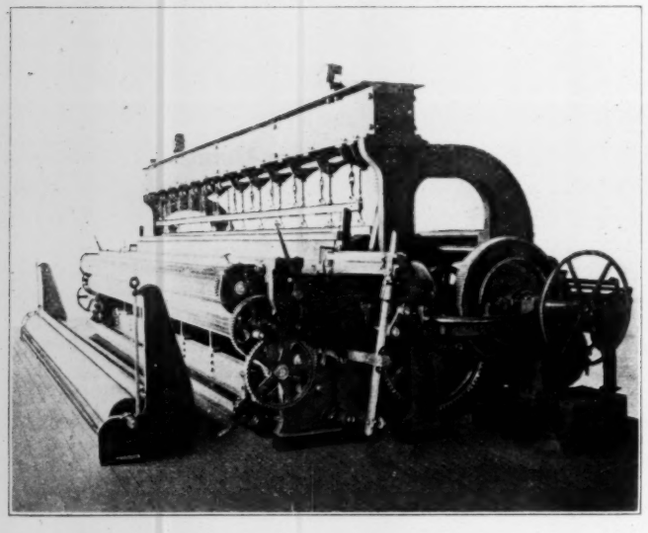


FIG. 2 SPECIAL EXTRA HEAVY DUCK LOOM

mechanism is of particular advantage when applied to looms in which the filling is customarily wound on a butt instead of on a bobbin.

THE JACQUARD

Another very interesting and clever device for use with these looms is the jacquard, which was invented by a Frenchman of this same name in about 1800. When complicated patterns or patterns of great length are to be woven there is no combination which can be made so that the warps can be grouped and handled by heddle frames. Each single warp thread must at times be individually raised and lowered, and to accomplish this each thread is passed through a "maileye" in a heddle. At the lower end is a weight or "lingo" to draw it down. The upper end is passed through a board above the warp in which holes are drilled for each cord to hold it in place. Where the pattern repeats itself across the goods the similar cords from each pattern are brought together into one neck cord, and these cords pass to the jacquard machine above the loom. Here the cords are attached to the lower ends of upright wires in the upper end of which a hook is formed. These hooks are arranged in rows, and in front of each row is a knife or "griffe" which is constantly moving up and down in the proper time. Normally the hook is free from the griffe. Near the top of the hooked wire is a projection on a horizontal wire bearing against the upright wire in such a manner that if the horizontal wire is moved lengthwise it will

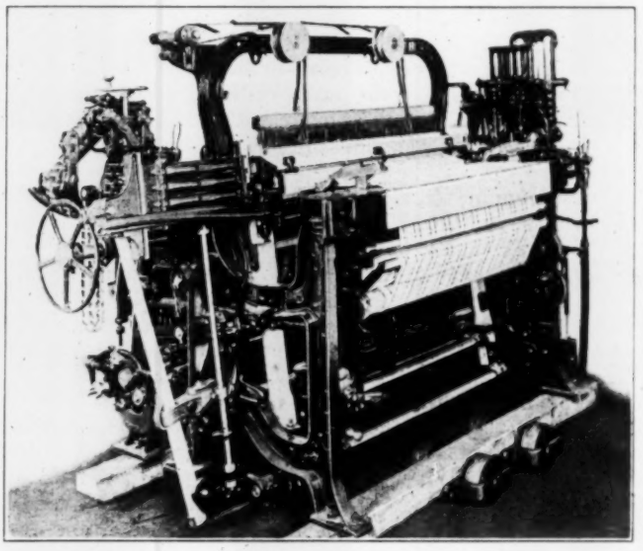


FIG. 3 AUTOMATIC GINGHAM LOOM

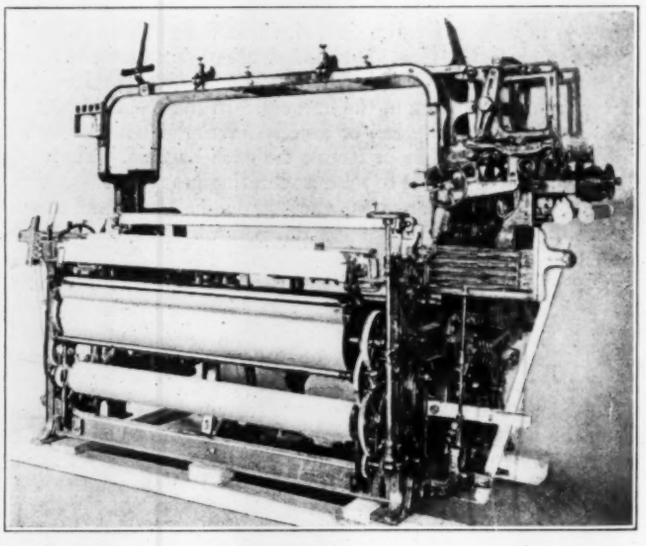


FIG. 4 DOBBY SILK LOOM

place the hook in engagement with the griffe. There is one horizontal wire for each hook. They are arranged in horizontal and vertical rows. At the outer end of these horizontal wires is a rectangular cylinder mounted so that it can be revolved, and moved to and from the wires. This cylinder carries on it a series of cards, and presents one card to the wires each pick. The card is pressed against the ends of the wires, and unless there is a hole in the card the wire is moved lengthwise, causing the upright to engage the griffe, which moving up raises the cord and its corresponding warp thread. Holes are punched in the cards so that only the wires which are selected will move lengthwise, and the holes are punched in such an arrangement that they will weave the desired pattern. This machine is a development of a so-called old draw loom in which the cords were bunched together and pulled by the hand of

a draw boy who attended to this part of the process while the weaver attended to the remainder.

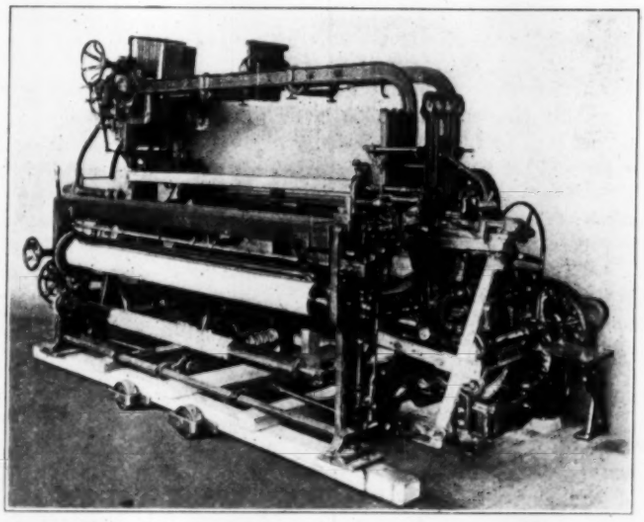


FIG. 5 AUTOMATIC INTERMEDIATE WORSTED LOOM

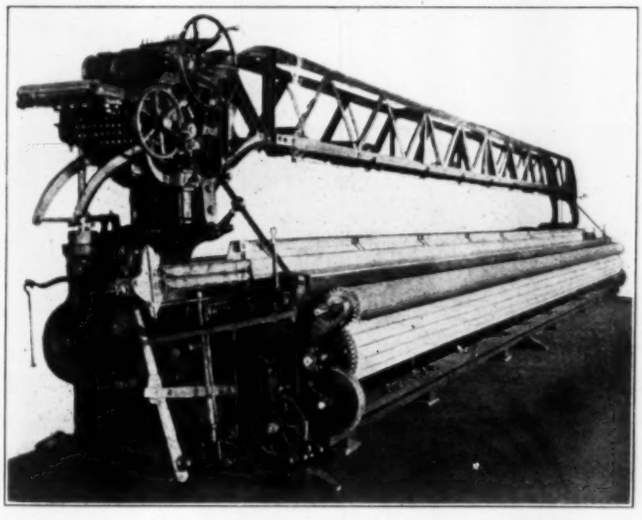


FIG. 7 EXTRA HEAVY FELT LOOM

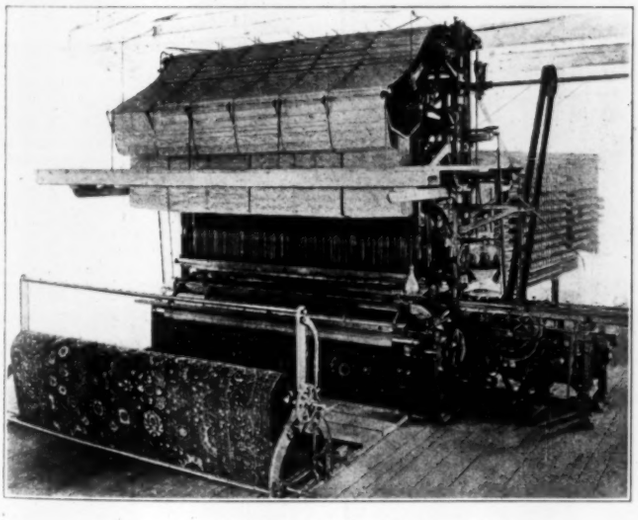


FIG. 8 COSTIKYAN PERSIAN CARPET LOOM

DIFFERENT TYPES OF LOOMS

To weave all the various fabrics which were first mentioned a great number of different types of looms are of course required.

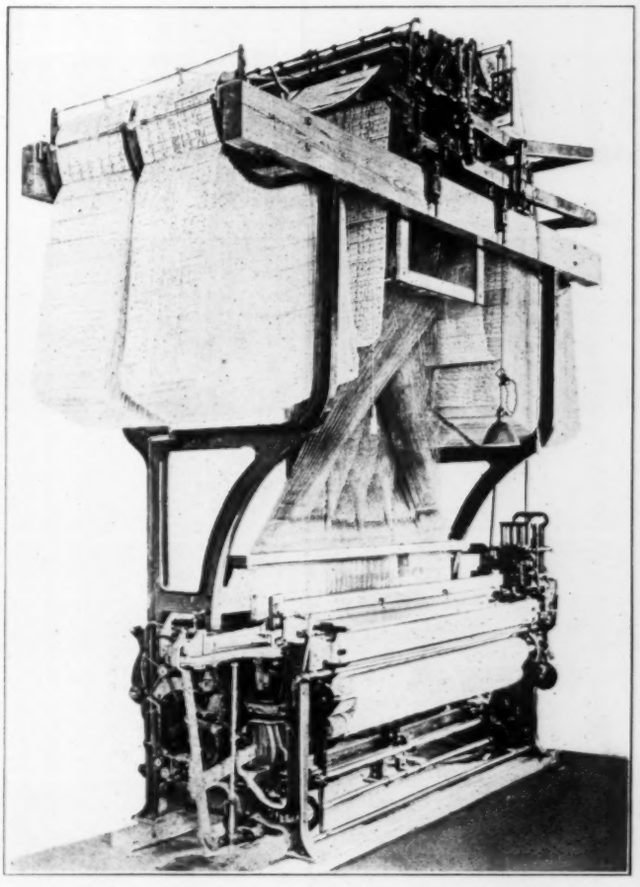


FIG. 6 AUTOMATIC TABLE-DAMASK LOOM

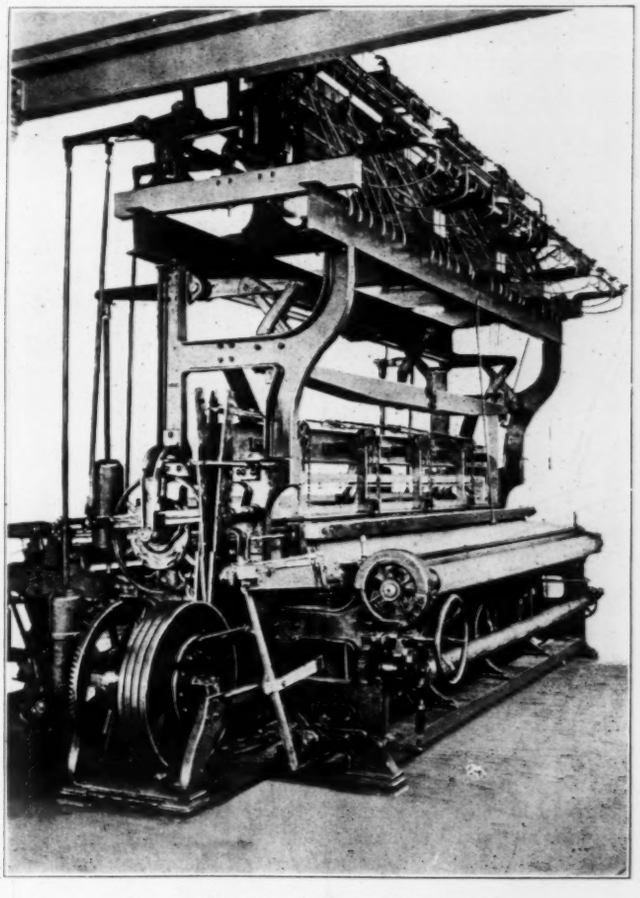


FIG. 9 STATIONARY WIRE WILTON LOOM

The simplest are naturally those for the plain weave. The shedding motion for this class is the face cam under the loom, pulling one harness down, and straps and rolls raising the opposite ones. The principal variation in these looms is in the weight and strength. They run all the way from the light cotton loom weaving print cloth or muslin 27 in. wide up to those which are suitable for ducks and tire fabrics (Fig. 1), and finally to those machines for the heaviest or 12/0 duck up to 240 in. or 20 ft. in width. This is

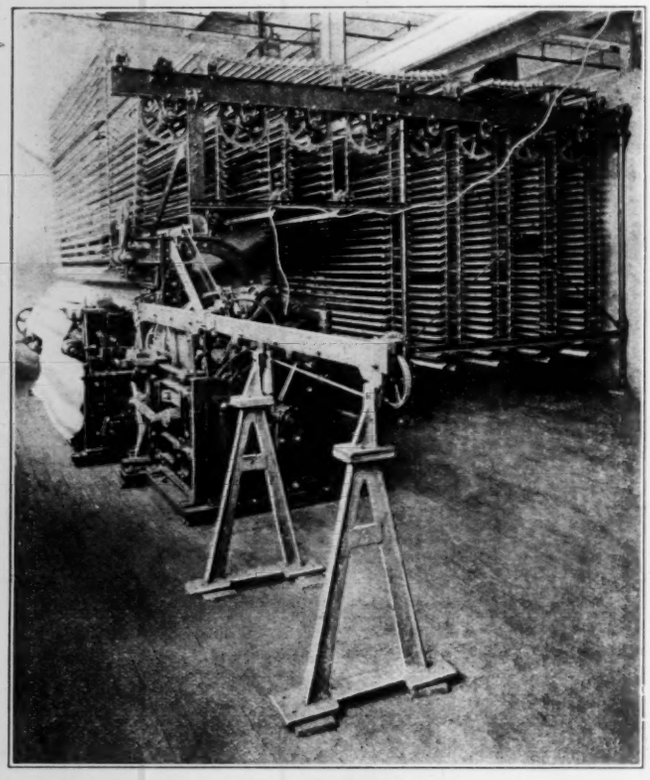


Fig. 10 Smith Axminster Carpet Loom

probably about as heavy fabric as is woven. The loom (Fig. 2) for this purpose weighs about thirty tons. This fabric is used for receiving wet-pulp and paper-making machines.

The gingham loom (Fig. 3) is very similar in construction to this. It is equipped to handle two, four, or six colors, and is therefore equipped with a box motion. The pattern for the weaving is only two, three, four or five harness, and so the simple cam shedding motion is employed. The color pattern, usually being checks, etc., is of great length, requiring a very long pattern chain, and therefore the loom is equipped with a multiplier.

Looms for weaving silk (Fig. 4) are of great variety, plain looms where the cloth has only one kind of filling, and two shuttles for weaving crepe, requiring two kinds of filling up to four and six colors for the fancy silk. They are almost always built for many harnesses, usually twenty or more, not only so that the fancy patterns can be woven, but also so that in weaving plain goods the warp ends can be divided into more groups and placed on more harnesses on account of their fineness and the great number.

For weaving the ordinary fabric of clothing for men's and women's wear there are the heavy-worsted looms, intermediate and dress-goods looms. These are all very similar except in weight and strength. The first loom is suitable for heavy cloth such as overcoating and men's wear in general.

The intermediate-worsted loom (Fig. 5) is similar in almost all respects except being of lighter weight for the lighter weights of men's wear, etc., and the Gem loom or dress-goods loom is still lighter, but in general is similar to the other looms, and is intended mostly for material for women's wear. These looms nearly always have the full fancy Knowles head so that almost any pattern can be woven. They carry four shuttle boxes on each side of the loom so that it is possible to use a maximum of seven shuttles although more than four shuttles adds greatly to the complication of the pattern chain for the boxes, and are not generally used.

Looms for table damask (Fig. 6) are usually plain looms, but having very large jacquards on account of the large and complicated patterns which are woven, there being seldom any repeat in the pattern in the entire table cloth.

Looms for weaving blankets are usually built with the cams at the ends of the loom, as many as eight harnesses being used for weaving double blankets. They provide for a great length of pattern for the colors or boxes as blankets usually have a border on each end. For fancy blankets a jacquard is almost always used.

Felt looms (Fig. 7) are very similar to the ordinary looms for weaving worsteds, and are notable only for their great length; the longest loom being 480 in. in length or 40 ft., and weaving a cloth in the form of a tube, which when cut would be equivalent to an endless belt about 76 ft. long. These cloths are used to form a paper-conveyor belt in paper-making machinery.

There is an endless number of looms for more or less special purposes: the cane loom for weaving rattan seats for trolley cars and similar material in which the filling is drawn across the loom by means of a nipper carried on the end of a needle; looms for weaving various kinds of grass and straw matting, which are

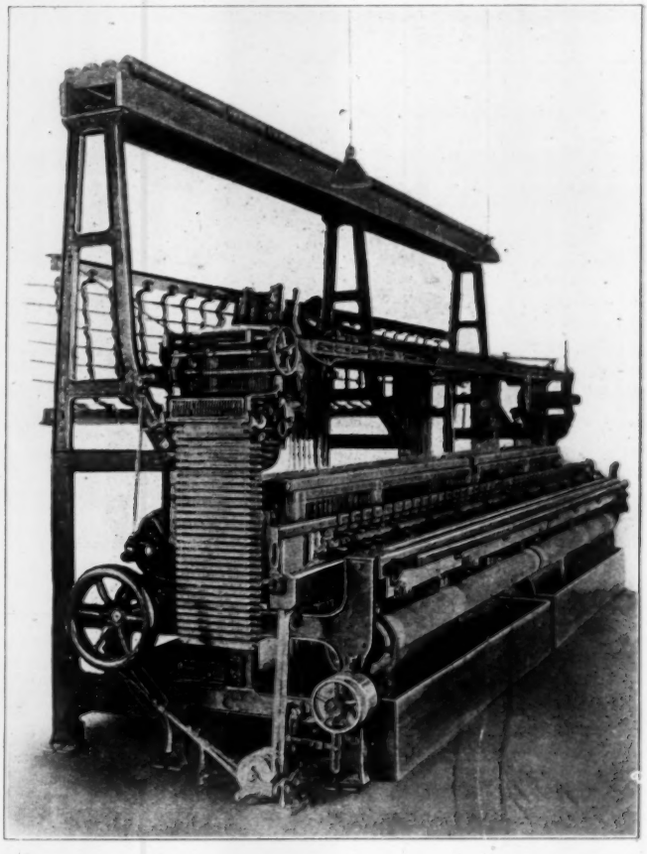


Fig. 11 Ribbon Loom

comparatively simple and have special requirements for the kind of matting which they are intended to weave, those for weaving grass rugs having a very large shuttle; looms for weaving hammocks, and looms for weaving mosquito netting, which products are of the leno type.

There are also the looms for weaving terry or Turkish toweling. In these looms the reed or the lay is held back from making its full travel forward for two or three picks according to the character of the goods. These two or three picks bind a portion of the warp to the filling and on the third or fourth pick when the lay is allowed to complete its travel a portion of the warp is carried forward and formed into a loop; The portion of the warp which makes the loop being released from any tension in the let-off at the proper time.

The looms for weaving velvet and plush are similar in construction except, for the double plush or double velvet, the lay carries two shuttles one above the other and these shuttles are thrown through two separate sheds, one from above the other. The pile is controlled by a separate let-off which releases a certain specified amount of pile at each pick and holds the two pieces of goods a certain distance apart. They also have in addition the cutter motion which passes a knife forward and back between the two pieces of cloth each time, the cloth being stretched tightly and held apart by the take-up rolls. Single plush is woven on a loom very similar to those used in weaving carpet, a wire being passed through on each pile pick. They are similar in other respects except that they have the wire motion which passes the wire through the shed.

The constant demand for new fabrics and for very special materials make the combinations and varieties of looms which are demanded almost endless.

There are also looms for weaving the various kinds of carpets (Fig. 8). The Brussels loom, with a knife placed on the end of the wire, makes a Wilton carpet (Fig. 9). In this loom there is a jacquard and a wire motion. The wire motion passes the wire through the shed on each pile pick, and the looms are built to weave carpet up to 12 feet in width or 16/4. In this carpet there is a set of worsted warp threads for each color which appears in the pattern, four, five or six sets of worsted yarn or frames, as they are called. There are seldom more than six frames or more than six colors used. The pattern is formed by raising the color required over the pile wires so that it will appear on the face—the balance of the worsted yarn being buried in the back of the carpet, the different threads being raised so as to form the pattern in color. Thus the greater part of the expensive yarn is buried in the back of the carpet and cannot be seen, and while it makes a very soft and beautiful carpet it is also very costly.

The tapestry loom for weaving tapestry carpet, which when cut forms the Wilton, gives a similar effect in a much cheaper way. This loom is very much the same as the Wilton loom except that no jacquard is employed, and there is but one set of worsted-yarn threads, and on these the pattern is printed on the warp before it is woven; each thread being of different colors throughout its length, and each thread is always on the face of the goods, but put together in such a manner as to form the pattern, the thickness and body of the carpet being provided by a stuffer. The warp is printed on a printing drum, each single thread being wound on a drum of such circumference that one turn carries sufficient yarn to make one repeat of the pattern. A printing wheel carrying the color is then drawn across the face of the drum, coloring just sufficient length of thread to form one tuft or loop. The proper number of threads to form the entire warp are printed on different drums and they are then matched together so as to form the pattern, wound on a beam and made ready for weaving.

In weaving the Axminster carpet (Fig. 10) each tuft is set into the carpet separately, and there is no worsted thread running lengthwise of the carpet or concealed in the body. The pile or tuft yarn is wound on small spools of sufficient length to make the entire width of the carpet. There is one spool for each row of tufts and there are as many threads on the spools as there are to be tufts in a row. These threads are of various colors so arranged on the spools that they will form the pattern. They are carried in a chain and one spool is presented to the loom each pile pick. The loom lifts the spool from the chain, lays the yarn in the carpet, the warp binds it in place, and the loom cuts it off from the spool and returns the spool to the chain. The chain moves forward one station and presents the next spool to the loom, the process as noted above being repeated. For a rug 9 ft. by 7 ft. there would be from 500 to 700 spools in accordance with the fineness of the carpet, and there would be from 400 to 600 threads on each set of spools.

In the chenille carpet two looms are required to produce the carpet, one to weave the weft for the main loom. The weft looms are small machines of plain construction and they weave a number of lines of fringe or chenille, which when spread lengthways makes a narrow fabric only a few threads wide with a wide fringe on each side. This in turn is used in the main loom as filling. The loom weaving the carpet runs for three picks and then lays a row of the chenille in the loom and stops, and the weavers comb the fringe or pile into a vertical position by hand, when the loom is started again. In much of the chenille where the pattern is at all complicated the chenille is put into the loom by hand, the chenille being wound on a stick and passed from one weaver to the other lengthwise of the loom.

For weaving ribbon (Fig. 11), tape and all narrow fabrics many pieces are woven at one time in one loom. There is a shuttle and a weaving space for each piece of goods, but the shuttles instead of being thrown across the loom by a picker stick as they are in what is known as a fly-shuttle loom, are moved positively from side to side. There is a block about the length of the shuttle on each side of the weaving space, and on the bottom of the shuttle is a rack. In this rack is meshed a pinion turning on a pivot in the block. Below the cloth and meshing with the lower side of the pinion is another rack passing the whole length of the loom and meshing with the pinions which drive each shuttle the whole length of the loom. As the rack is moved lengthwise it turns the pinion and forces the shuttle from the block across the weaving space. On the other side of the weaving space is another shuttle turned by the same rack which picks up the shuttle before it leaves the first mentioned pinion and carries it into the block. The motion of the rack is a reciprocating one and when it is moved in the reversed direction it carries the pinion back across the weaving space and into the first-mentioned block. The other motions of looms of this type are practically the same in construction as those for weaving broad fabrics, and are varied to suit conditions.

BURNING BITUMINOUS COAL ON TYPE E STOKERS

(Continued from page 374)

Care is taken to have the fire from 10 in. to 12 in. thick, keeping the draft over the fire as indicated by the draft gage at about 0.5 in. Under these conditions the draft under the fire will average from 3 in. to 5 in. and the draft in the last pass about 0.4 in. to 0.6 in. These figures are for our usual running conditions at 100 per cent rating.

The variations will depend on whether the coal is largely dust or in small lumps and whether it cokes to form a crust which prevents air supply. The greater the tendency to coke, the greater the air pressure required.

The firemen are instructed to keep the fire level and to use the fire tools as little as possible and to keep the draft above the fire uniform. The fires are dumped every 2½ hours and very little trouble from clinker in the ash dump is experienced.

Approximate analysis of coal fired in two boilers which, operated at from 125 to 150 per cent rated capacity, are sufficient to carry our load at all times, is as follows: carbon, 71.17, volatile, 20.04, ash 7.70, sulphur 1.09, moisture 1.20, B.t.u. 14,643.

About 1500 lb. of coal is burned per hour during the day in each furnace, which has a projected area of 71 sq. ft., and about 1050 lb. per hour during the night. The stoker speed is hand-controlled. Two of the boilers are equipped with the Bernitz furnace walls for admitting air above the fire all around the furnace, the other two admit air through openings in the rear wall only. We have had very little trouble with clinker on the walls of any of these boilers. Ash is wet down in the ashpit immediately after dumping and is removed from the ash hoppers in basement by cars of about 1000 lb. capacity. No scales are provided to weigh the ash regularly, but occasional weighing indicates about 12 per cent ash by weight of coal burned. This includes water in ash.

Operation is practically smokeless. There is no dense black smoke at any time, and light smoke during short periods only. Air is admitted over furnace to secure good combustion between fuel bed and tubes. The lower side of the front header is 10 ft. from the floor line and combustion is complete before the hot gases reach the lower tubes.

During the fifteen months the stokers have been in operation, no trouble due to manufacture or design has been observed. When first put into service, however, several grate bars were burned out, due to the failure of the firemen to remove the siftings from the central air box promptly.

Management Applied to Textile Plants

The Organization of a Cotton Plant and Its Management—Comparison of Cotton-Manufacturing Development in the North and South

By GEORGE S. HARRIS,[1] ATLANTA, GA.

A COTTON mill is a highly organized plant consisting of four or more distinct departments, all quite different, and to master the details of any one requires long study. The departments in order are, mechanical, carding, spinning, weaving, and cloth. The last named includes the classification, branding and packing.

The stock in process, cotton, consists of fibers very sensitive to atmospheric conditions and easily damaged in working. This fiber under a microscope appears like a minute glass tube slightly flattened and slightly twisted. It is covered with a very thin coating of wax, normally has a moisture content of about 8 per cent and beyond the carding process works better when the moisture content is held at or about normal. The effect of picking and carding is to dry out the moisture and as it is in these processes we attempt to separate the good fiber from the dirt, leaf, and short and immature fiber, we need to have the stock dry to properly effect this separation. Beyond the carding we begin the parallelization of the fibers and evenly drawing down the stock through different processes until the required yarn sizes are ultimately reached.

During these processes the atmospheric conditions must be controlled, as it is quite apparent that unless the correct percentage of moisture is maintained in the air surrounding the fibers at the prevailing temperature, the air is going to extract from or deposit on the fiber the shortage or surplus of moisture as the case may be. It has been determined by engineers experimentally just the percentage of moisture necessary to be maintained in the mill atmosphere throughout the range of temperatures to effect the necessary regain in moisture content of the cotton fiber. It naturally follows that a certain moisture content in air at one temperature would not be correct at another.

In addition to the departments referred to we very often find a finishing department, including bleaching or dyeing or both. In fact, with some few exceptions, all cotton goods are given some kind of finish after leaving the loom before they are ready for consumption.

Department Personnel

To properly man such an institution as this we must have at our command men of various qualities and training—the master mechanic, the carder, the spinner, the weaver, and finally the finisher. In the older countries where competition is keener and men progress only by specialization, we seldom find a manufacturer attempting the whole works as we do here, especially in the South. There, one mill produces yarn only and attempts only carding and spinning. Another mill attempts weaving only, buying its yarns from a man devoting his whole time and attention to carding and spinning. Likewise the cloth is sold as it comes from the looms to a converter who has it finished by a man who possibly doesn't know a loom from a card but has spent his years training in the arts of chemistry, of dyeing and allied subjects. Whether the one system is better than the other is a question for debate, but as the industry is successful under both systems, probably local conditions in either case had their influences in its development.

The mechanical department consists principally of power plant and shops, but in reality extends over the entire plant to reach all power-transmission equipment, fire protection, service lines, steam and water, sanitary system, machine repairs, building repairs, etc. All of this very naturally requires for its directing head a man trained in the many branches of engineering, mechanical, electrical, and otherwise. In the South the plants are often isolated and the mechanical department sometimes finds itself in deep trouble and thrown absolutely on its own resources. The head of the department must be competent to demand and hold the respect of the heads of other departments who are not mechanics, and to stand firmly in the organization as his title implies—master mechanic. No position in a textile plant is of more importance.

The general appearance, or we might call it the tone, of a textile plant depends on the character of the master mechanic, and frankly only a small percentage of the men who have come under my observation fully meet the requirements.

Continuing our trip through the plant, we find the carder. He has his picking, carding, drawing, slubbing, and roving—all different processes—with every pound of the stock passing through each process in the order named and in constant danger of being damaged. The carder, as do all department heads, has his department divided into sections, with each section under the care of a "section man."

In the next department we find the spinner, who receives the stock from the carding department in the form of roving wound on wooden bobbins. This roving is specified as a certain "hank" roving. By this is meant that a certain number of hanks will weigh a pound. For instance, a four-hank roving means that the stock has been drawn down to such a size that four times 840 yards (one hank) will weigh a pound. The roving must be evenly drawn. That is, it must be reasonably free from thick and thin places, it must be properly carded free from specks of leaf and have the greater portion of the short fibers removed, and it must have only sufficient twist to make it hold intact while being wound on the bobbin and off again. The head of this spinning department must see that this roving (his raw stock, so to speak) is up to specifications. He has in this department spinning, spooling and warping and delivers to the weaving department warp yarn wound on large spools, or beams, as they are called, and filling yarn wound on wooden bobbins or cops, in condition to go directly to the loom shuttle.

Next as we follow the stock through, we find the weaver, who usually has in his division of the plant slashing or dressing, warp preparation, and finally weaving. To fully meet requirements he must know cloth analysis to be able to positively determine yarns, harness, reeds, and loom "set-up" necessary to produce a cloth without unnecessary cutting and fitting, which unfortunately is common practice with many. In the slashing of warps, to produce not only the correct finish on the cloth but a good running loom, requires a knowledge of starches, fats and various chemicals brought together in making up the finished size which is pressed into the yarns and dried over large copper drums.

The finishing department, whether it be bleaching, dyeing, or both, finally finishing the cloth into one or more of the thousands of finishes given to cotton piece goods, is a department very different from any we have yet seen. In this department you will probably find a chemist with his laboratory prepared for testing the great number of dyestuffs and chemicals required to produce the different finishes. You will find the dyer, trained by experience and experience only, to produce the great number of shades required, and then the finisher, who takes the dyed or bleached cloth and gives it the feel, sheen, etc., required.

A department head lacking in the mental capacity, training and industry necessary to hold up his end will surely drag down all other department heads to his level—and this can often be accomplished in a remarkably short time. This is due to the fact that cloth manufacturing consists of a long series of processes through which this very sensitive cotton fiber must pass on its way from the bale to the case of finished goods, and to the fact that at any point serious damage can occur which is very difficult to detect at once but which readily shows itself in the cloth-testing laboratory. Many a mill manager has been worried for months with the knowledge that certain of his fabrics are not up to standard quality and yet has been unable to locate just the process that is causing the damage.

[1] President, Exposition Cotton Mills.

Presentation at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of The American Society of Mechanical Engineers. All papers are subject to revision.

MANAGEMENT AND THE MANAGER

The general subject of management has always been an interesting one to my mind, and I believe that during the next few years managers as a class all over the globe are to meet trials never before encountered. We are all familiar with the three-legged table supporting industry—the labor leg, the capital leg and the management leg. It is generally conceded that no three-legged table can stand on only two of its legs, but occasionally we hear of a labor leg somewhere deciding that his particular table is fully able to stand without the management leg, or in some cases the labor leg feels that the table might be more substantial if we take some of the stock out of the management leg and put it into the labor leg. Naturally the table is weakened directly in proportion to the amount of stock removed from any one of the legs.

Management, to my idea, is more or less a matter of compromise and it is just as erroneous to uncompromisingly dictate to men without feeling their sensitiveness, as it is to attempt to twist a cotton fiber in a way it will not twist without damage.

Men—and of course I mean men who have not been advanced beyond their capacity—should feel their responsibility and should be allowed to work out their problems in their own way. A manager to stand firmly as such must have had the necessary experience in all the various departments, and he finds it difficult at times to see an assistant apparently wasting time by taking a circuitous route to an object, but the man should be allowed all possible leeway and be checked only when he is about to do some real damage. It is to my mind poor management to feel that every man must be made to do my way. Unless a man is given an opportunity to try out his ideas without fear of being discharged for mistakes, he stops thinking and becomes a machine.

Men should be taught to feel that it is their duty to train other men. They should be taught by the management that their advancement depends always upon their having ready an understudy. I recall reference in a paper once to the "three-point system of promotion" and have always remembered my impression. Picture an organization from manager down where each man in line is trying to promote himself by making the man ahead so good that he must outgrow his shoes and at the same time training an understudy for his own work. You have then an ideal organization.

When a vacancy occurs a good man will comb thoroughly his own organization before going outside, but I don't think a manager should ever promote a man unless that man can show that one or more of his assistants is ready for his work. When a man is fully filling his part in an organization he is continually pushing forward the man just ahead and pulling the man just below. No man, regardless of his competency, should ever receive promotion who has ever attempted to drag down another in his organization or in any manner attempted to interfere with his progress.

Plant managers require the full loyalty and attention of every man on the staff, and a manager who does not possess that personality so necessary to develop loyalty and interest in his assistants, is surely unfortunate and so are his stockholders.

There is hanging on the walls of my office a card bearing this inscription by Elbert Hubbard: "Men are valuable just in proportion as they are able and willing to work in harmony with other men." Please get this firmly in mind. Several years ago I had copies made and posted them throughout our plants and have been interested in seeing its effect on the men. I commend this to employee and employer alike as carrying a lesson well worth any man's careful consideration.

In industrial management today we have two extremes. On the one hand an uncompromising autocrat who sits at the head of an organization dictating without regard to the thought or feeling of the men in charge of departments, and on the other hand the recently developed industrial democracy with the governmental bodies of men from the works either appointed by the head of the establishment or elected by the workers en masse, or both.

I feel that either one of these extremes is just as bad as the other and both with few exceptions will eventually go on the rocks. I have more tolerance for the industrial democracy plan of management than the autocratic management, but neither is good nor necessary. Somewhere between the two ideal management is found.

Here you find a man firmly in his position by reason of his personality, capacity and training. He knows his work and can intelligently direct with an understanding of the difficulties ahead of the men when they attempt to carry out his instructions. He is naturally careful and thinks out his plans after discussing details with the men who are ultimately to do the work. This is not possible for any man to do before he has mastered details in the plant. An industrial plant is not a military establishment and cannot be successfully handled as such. The main object in any army, it seems to me, is to "pass the buck," while in industry every man in authority should be prompt to stand firmly on his responsibility and never attempt to shift his burdens to others.

The industrial democracy idea is pleasant to think about as it carries beautiful ideas of the brotherhood of man, etc., but human nature is the same the world over and in my opinion this plan generally will not succeed. There will be found an occasional exception where local conditions or some man or men in the organization are gifted with certain qualifications that make it all a success. But these exceptions are and will be rare. Men of today have developed through a long process of the "survival of the fittest" and the result has been a certain amount of selfishness in all men. Those who had no selfishness in their make-up and insisted upon giving away to others everything they gained, were stamped out before our day and left no posterity.

SOUTHERN COTTON-MANUFACTURING DEVELOPMENT

It has been suggested that you might be interested in a few ideas on the development of cotton manufacturing in the South as compared to that in other sections. As you know, for a term of years our development was phenomenal, until today the cotton-growing states are making into yarn or cloth considerably more than half the cotton manufactured in this country. Of the 37,000,000 spindles in the United States, the cotton-growing states have 16,000,000, or more than 43 per cent. The mills of the cotton states are now consuming 55 per cent of the cotton consumed in the country, with a steady increase. This has been accomplished in comparatively a very short time and it might be interesting to see how it was brought about.

Before the successful development of the humidifying apparatus, cotton mills were confined to certain localities in which could be found natural atmospheric conditions permitting weaving and spinning. This very largely accounts for the mills of England and later those in our New England States. In the Southern States the hot, dry summer so necessary to the growth of cotton did not encourage the spinner and the few mills we had in the old days were located on the banks of rivers for the dual purpose of supplying power and natural humidity. Some mills were scattered over the South, but the real growth was in New England.

In 1881 a few leading citizens of Atlanta conceived the idea of creating something that might stimulate cotton manufacturing, and the result was the Industrial Cotton Exposition. This was held in Atlanta and exhibited everything from the cotton growing in the field to the finished cloth, with the actual manufacturing being demonstrated. As a finishing feature a real wedding ceremony was performed in the building with both the bride and the groom wearing clothes made of cloth produced with the machinery on exhibition from cotton grown in the surrounding fields. Immediately following the close of the exposition a new company, the Exposition Cotton Mills, was organized and began the manufacture of cotton goods on a commercial scale in these same buildings, and from this nucleus the present Exposition Mills have grown.

As the real growth of mills in the South dates from a time soon after this exposition, it seems fair to assume that it was quite largely responsible for this growth and those of us who have the honor today of occupying official positions in the Exposition Cotton Mills feel proud of the part our mills played in the development of our industry. We have today, framed in our office, one of the original certificates of the capital stock of the International Cotton Exposition. More than this, a part of our present equipment is now running in the original wooden buildings that housed the exposition.

The development of southern cotton mills was assisted greatly in later years by the perfection of humidifiers which made it possible

to build a mill anywhere and operate it successfully through the summer months.

It might well be asked why the southern mills advanced so much more rapidly than those in any other section, and I will attempt to answer, in part at least. We will take for comparison a mill in Georgia and another in Lowell, Mass., without any intention of discrediting what has been achieved by our friends of New England. As a matter of fact, we of the South marvel at their ability to show such financial results under their conditions.

First, in the matter of cotton the Georgia mill has the advantage. When the mill in Lowell requires cotton it first deals with a local broker who will probably place the order with one of the many cotton shippers maintaining a large organization covering more or less the entire cotton belt. These shippers in turn will buy the cotton from smaller shippers operating in one locality who might buy direct from the producer or from a merchant who has taken in cotton on account of supplies furnished during the growing season. The cotton, before it can start on its journey, is concentrated at some point for compression. Here it receives considerable handling and is compressed to a high density. By the time it reaches New England it not only has accumulated a very high freight charge, but the percentage of tare has been increased at the compress.

In contrast to this long process with its three to four necessary profits, the Georgia mill will buy generally from the local shipper and might buy directly from the large responsible producer, with transportation cost usually only a few points. In addition to this the mill in Georgia can handle uncompressed cotton, saving the extra tare and expense incident to compressing, besides the extra mill expense in opening compressed cotton. I have never been in a position to make a dollar-and-cents comparison of this cost of cotton, which would naturally vary with the seasons, but the difference must always be there and in some seasons it must be considerable.

The labor cost has always been in favor of the Georgia mill, due as much as anything else to climatic conditions. The long, hard winters of the North necessarily make the cost of living very materially higher, which must be borne finally by the manufacturer in his payrolls. In the South from the beginning the mills found it necessary to provide homes for the operatives as this proved to be a decided economic advantage, both to the mill as well as to the operative. The village plans today are given the same consideration as the mill plans in the original layout. This has given the operative a far more comfortable home at a much less cost to the mill than if supplied by outsiders who haven't the same interest in the operatives or the mill. Furthermore, this scheme of things has tended to keep the relationship between employer and employee closer. Contrast this with the operative in New England who lives in a house probably one or more miles from his work and which he rents from a landlord who has no interest in him beyond that of keeping his property occupied profitably.

There was a time when this was very largely offset by the higher efficiency of the labor in Massachusetts, but this advantage has now been shifted about. With every year our labor has been growing more and more efficient, while the original labor of Massachusetts has been replaced each year at a steadily increasing percentage with untrained immigrants. I recall my first day in Lowell as a boy where I went to take courses in the Lowell Textile School. Standing near a mill gate at noon and observing the help passing out, I had to listen carefully to hear the English language spoken. Instead what I did hear was, as it seemed to me, every language of the world. I learned afterward that twenty-six different nations were represented in the mills of Lowell at that time, and that was more than twenty years ago. This, together with the advent of labor organizations, has created a condition that tends toward anything but efficiency.

In contrast to this, in a Georgia mill is a class of labor, all American, recruited from the farming class. The manager has grown up with them and knows them in their homes. In many cases the mill, being a comparatively young institution, was built from a small unit by the present owners. The manager, living in close touch with the labor, is in a position to talk freely with them. I know of instances in Georgia, during the recent depression, where values depreciated so fast that it was impossible for a mill to continue operating without tremendous losses, but the employees quickly sensed the entire situation and voluntarily submitted to reductions in their pay in order that the mill might continue to operate. Do you hear of such actions in the union-ridden mills of New England? I have not. The result is that while the Georgia mill is in position to sell its product today in line with the depreciated value of raw products, the New England mill has its manufacturing cost held up fictitiously and is forced to take heavy losses in current values or shut down.

In conclusion, allow me to refer again to the legs supporting industry, with special reference to the management leg and American industry. Do you fully realize your responsibility during the next few years? It is up to the management to attract, hold and keep employed labor and capital. They are both free and when management fails to function they both withdraw and industry becomes stagnant. Our recent road has been a hard one, but now the capital is here, the labor is here, and world competition is also here; and it is going to take brains, and active brains in the heads of management, to direct capital and labor so as to place American industry in the front rank and hold it there.

Bleaching

Bleaching, Being a Résumé of the Important Researches on the Industry Published During the Years 1908-1920, by S. H. Higgins, Head of Research Department, Bleachers Association, Ltd., London, England, is a comprehensive monograph. It is limited to the subject of bleaching and the discussion of factors that may affect it, exclusive of the purely technical processes of bleaching. The following is cited as possibly giving the scope of the treaty. Many questions have been raised as to proper way of handling mercerizing. Must the fiber be kept under a condition of strain during part of the process, and to what extent might the mechanical treatment be replaced by chemical action? And if, as some assert, a long staple cotton is necessary for success, is this success due to a change in the chemical or molecular nature of the cellulose, or to an alteration in its physical characteristics induced by the initial processes to which it has been submitted? Among the multitude of advisers it may not be indiscreet to ask whether we know the cause or causes of the peculiar appearance of the fabric following mercerization. One authority states that the fibres untwist during mercerization, and retwist often in opposite directions, and that the luster produced depends largely on the reflection of light by the swollen and retwisted fibers. From this hypothesis the conclusion is drawn, that the mercerizing agent, which is able to produce the highest degree of swelling, shrinking and untwisting of the fibers, gives the maximum lustre. Another view is that luster is due to the smoothness of the surface of the mercerized fibers as compared with ordinary cotton fibers. Mr. W. C. Balls declares that luster is almost synonymous with twist. If all the hairs in a sample are well and evenly twisted, there will be an infinite number of convex surfaces, each reflecting a spot of light. In quoting these various authorities, the object has been to show that other causes than chemical change may operate in producing the desired effect; but if adherence to purely chemical guides had been strict, the same diversity of opinion would have been apparent.

As regards removal of wax by saponification the chemist and the practical man have long been at issue, the former maintaining that caustic soda is the best saponifying agent, while the latter insists that the lime boil cannot be replaced for certain classes of goods. The author seems to agree with the bleachers in upholding the value of lime boiling, at least in some cases. He points out and, as it would seem rightly, that in the lime boil and "sour," that unsaponifiable portion of the wax and free fatty acids are left on the fiber, and in the lye boiling a soap is readily produced by the alkali and the fatty acid, resulting in the emulsification and elimination of the unsaponifiable portion. The difference of opinion probably arises from the various classes of goods and their variety of composition, to which the method is applied.

The author's work may be particularly valuable in preventing the repetition of many experiments that have been thoroughly tested: in suggesting ones along which progress is likely to reward research; and in delineating the limitations which the practical man may expect to encounter. (*Engineering*, Mar. 31, 1922.)

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

AERONAUTICS (See Internal-Combustion Engineering)

AIR ENGINEERING

CALCULATION OF PRESSURE LOSSES IN CONDUITS CARRYING AIR, STEAM OR WATER, V. LeBeau. According to the author's statement, the formulas given for pressure losses in fluid conduits are incomplete and lack precision because of their failure to take into consideration to a greater extent than is done the nature of the inner surface of the walls of the conduits; and further, because of lack of sufficient attention to such obstructions, as, for example, pipe joints. Thus, for example, Lorenz' formula in the Huette Engineering Handbook is found to be valid only for the case of compressed air, and then only for conduits from 50 to 350 mm. (1.96 to 13.7 in.) diameter.

The method adopted by the author is based on the use of the Reynolds coefficient, and a general formula for loss of pressure is developed in which certain coefficients are introduced to take care of the variations in the roughness of the conduit walls.

As regards the roughness, the author divides all conduits into four classes, viz., smooth conduits (drawn lead, copper, brass, or other tubing, the surface of which has been worked to a smooth finish); "first-class rough" conduits, which are iron and sheet steel tubes; "second-class rough" conduits, viz., cast-iron and cast-steel pipe, in which the resistance to the flow of fluid is greater than in conduits of the preceding two categories; "third-class rough" conduits, to which class belong wrought-iron, cast-iron and cast-steel pipes bearing incrustations or deposits on the inner surface.

Each of these four categories is discussed in detail and a formula derived for it, in addition to which the author has worked out curves from which pressure losses in a given type and diameter of conduit may be read off at once.

The article is of very considerable interest, but unfortunately cannot be abstracted more completely owing to lack of space.

As an appendix is given a brief discussion of the formula for determining the specific volume of superheated steam. The author rejects the formulas of Linde, Callendar and Tumlirz and expresses a preference for Zeuner's when so corrected as to bring it into conformance with modern views as to the variability of the specific heat of superheated steam with pressure and temperature.

In this way he obtains the following formula:

$$V = v + 100 \times C_{pm} \times \frac{t_1 - t_2}{P}$$

where V = the specific volume of superheated steam; v = specific volume of saturated steam; C_{pm}, the average specific heat of superheated steam; P, absolute pressure in kilograms per square meter; t_1, temperature of superheated steam in degrees centigrade; t_2, temperature of saturated steam in degrees centigrade. (*Revue Universelle des Mines*, Series 6, vol. 12, no. 4, Feb. 15, 1922, pp. 301–327, 8 figs., 2 charts, *tmA*)

AIR MACHINERY

Rotary Compressor with Disk Piston Moving in a Conchoid

PLANCHE ROTARY COMPRESSOR, Lucien Fournier. Description of a rotary compressor designed by a French engineer, R. Planche, based on a mechanical movement in which the transverse section of the cylindrical body of the pump is a circle enveloping a conchoid of a circle, the properties of which will appear from the following description.

The principle of action is as follows: A and B, Fig. 1, are the points of intersection of a straight line CD with the circumference of a circle about the center O. If, now, we lay off on this straight line on both sides of B two distances of lengths BC and BD equal and constant and greater than the diameter of the circle about O, the loci of the points C and D obtained by turning the straight line around the point A will be a conchoid of a circle, symmetrical with respect to the diameter passing through the point A which is the pole of the conchoid. All the chords of the conchoid passing through its pole are equal. In order that the two extreme points of the straight line CD of constant length should describe a conchoid, it is sufficient to make the point B the middle point of the line to move at a constant angular velocity about the center O in such a manner that it should describe the circumference of a circle, and at the same time the line CD about its middle point B in the same direction but at an angular velocity only half as great.

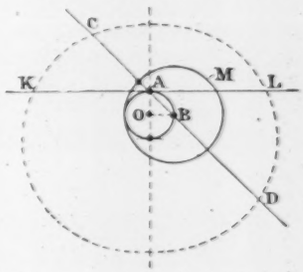


FIG. 1 DIAGRAM SHOWING THE PRINCIPLE OF GENERATION OF A CONCHOID

In order to obtain the combination of these two movements all that is necessary to do is to roll along the circle O without any slip, the circle M of double radius, this latter circle moving in one piece with the straight line CD. In this manner, while the straight line passes through a semi-rotational movement, its center B performs a complete rotation, as a result of which the totality of the areas located on both sides of the straight line in the interior of the conchoid is inversed.

If we substitute for the straight line CD a blade moving in the interior of a cylinder having a conchoidal base, we obtain in each period of complete rotation of its center B an intake and an exhaust, notwithstanding the fact that the blade has described only half a rotation in its enclosure. This is the principle on which the Planche rotary compressor is based.

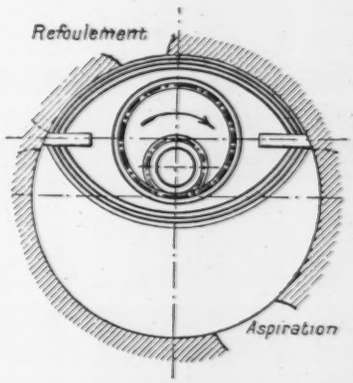


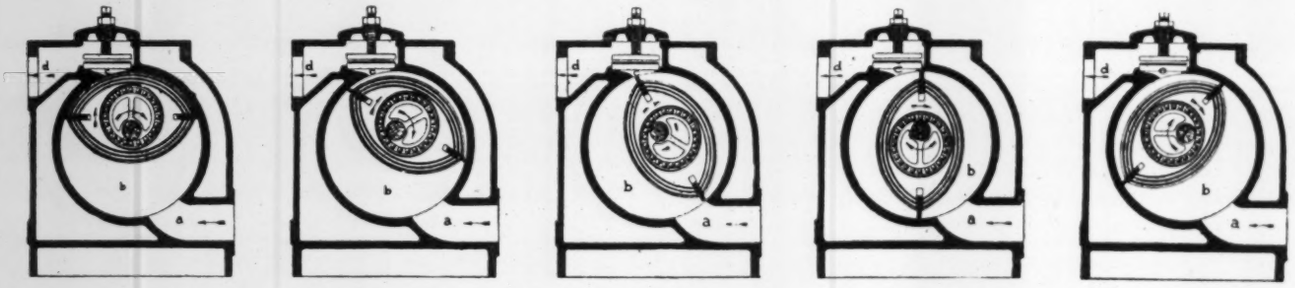
FIG. 2 DIAGRAM SHOWING THE PRINCIPLE OF DESIGN OF THE DISK PISTON, ITS RELATION TO THE DEAD CENTER AND THE RELATIVE POSITIONS OF THE INTAKE AND EXHAUST PORTS
(*Aspiration* = intake; *Refoulement* = exhaust.)

In actual practice, however, in order to make the machining somewhat easier, the conchoid of a circle is replaced by an enveloping circle of a shape fairly close to the theoretical curve. Instead of the blade a disk piston (Fig. 2) is used, which in one view has the shape of a rectangle, and in its longitudinal section appears as a symmetrical spindle, such that its median axis should occupy the position KL in Fig. 1, which corresponds to the dead center. Its outside surface is tangent to the cylinder.

The movement of the piston is obtained by means of an eccentric, the interior of which is constituted by the disk piston itself. The disk piston carries on both sides of its surface two internal gears which during the rotation of the shaft (Figs. 3 to 7) mesh with two rigidly held gears of half the diameter mounted on the engine frame. In this way the center of the disk piston describes a circle of uniform movement, while the disk piston itself turns around its own center in the same direction, but at half the speed.

Since, further, the disk piston is entirely symmetrical with respect to its own middle point, the centrifugal forces and the pressures are uniformly distributed on all sides and their resultant passes through the center of gravity of the disk piston which coin-

cides with the center of the eccentric. Hence, there is no torsion couple which might tend to oppose the motion of the disk piston around its center. The crankshaft and its eccentric alone absorb all the pressure reactions: two flywheels at both ends of the crankshaft are used to insure the balance of the machine. The question of stresses is discussed in greater detail in the original article.



Figs. 3 to 7 Timing Diagrams for the Disk Piston of a Planche Rotary Compressor

(In Figs. 3, 4 and 5 the air under its own inertia enters through orifice *a* into the space *b* where it is compressed. The gas compressed in the clearance space *c* expands and restores to the piston the power which it has absorbed during previous compression. In Figs. 6 and 7 the air is taken in on one side of the piston and compressed and exhausted on the other side, the exhaust taking place through *d*.)

The cylinder, as shown in Figs. 2 and 3 to 7, has two ports—intake and ignition—lagging with respect to the dead center of the machine and therefore not passing through the points K and L of Fig. 2. The lagging position of the ports is given in order to secure a better filling of the cylinders due to the fact that time is given to make use of the inertia of the column of gases flowing into and out of the cylinders.

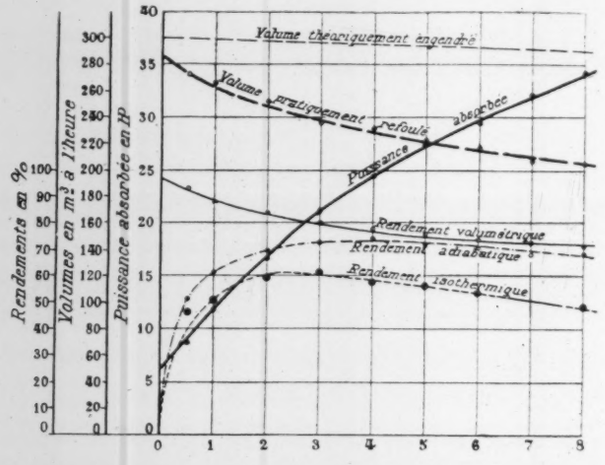


Fig. 8 Curves of Tests on a Planche Rotary Compressor

(*Rendements en %*—Efficiencies in per cent; *volumes en m³ à l'heure*—volumes in cu. m. per hour; *puissance absorbée en HP*—power consumed in hp.; *pression en kgs/cm²* (*au dessus de la pression atmospheric*—pressure in kg. per sq. cm. gage; *volume théoriquement engendré*—volume theoretically generated; *volume pratiquement refoulé*—volume actually delivered through the exhaust port; *puissance absorbée*—power consumed; *rendement volumétrique*—volumetric efficiency; *rendement adiabatique*—adiabatic efficiency; *rendement isothermique* isothermal efficiency.)

Tests of the device were carried out at the Laboratory of the National Museum of Arts and Manufactures on a unit rated at 300 cu. m. (10,594 cu. ft.) of air per hour, and have given the results shown in Fig. 8.

From this it would appear that the volumetric and isothermal efficiencies of the compressor are very high. At first glance it would appear that because of the high speed of the apparatus the compression should be a little too adiabatic. Actually, however, it is not so, as in these machines the compression and exhaust take place during one complete rotation, and the surfaces which are generated during the rotation are very large as compared with the volume of air which is exhausted, which factor assists good refrigeration.

It is interesting to note that the unit above referred to has also been tested as a vacuum pump and has given a vacuum of the order of 98 per cent. (*Le Génie Civil*, vol. 80, no. 12, Mar. 25, 1922, pp. 275–277, 10 figs., *dA*)

ENGINEERING MATERIALS (See also Railroad Engineering, Machine Parts, Testing and Measurements)

Stainless Nickel Alloy. Description of an alloy recently developed in England. It is known as "newloy" and is composed of 35 per cent nickel, 1 per cent tin, and 64 per cent copper, its peculiar characteristic being the absence of spelter and presence of tin.

It is said that it has already found extensive application for use as tableware. The alloy is very ductile and is made in rods, sheets, stampings and wires. In the latter form it appears that it may be used as a high-resistance wire. (*The Metal Industry* (London), vol. 20, no. 12, Mar. 24, 1922, p. 270, *g*)

HYDRAULICS (See Air Engineering, Machine Parts and Pumps)

INTERNAL-COMBUSTION ENGINEERING (See also Motor-Car Engineering)

Working Fluid of Gas Engines

Some Properties of the Working Fluid of Gas Engines, Prof. W. T. David. The following abstract is given in the words of the author of the article. An attempt is made in the article to clear up certain obscure points in the working of gas engines, and to describe some of the properties of the working fluid which have been ascertained recently from experiments made by the author. Before passing on to a detailed statement it will be convenient to summarize the main conclusions reached.

The article is divided into four sections. In the first section it is shown that incomplete combustion, increasing specific heat and cooling are all important factors in limiting the pressures developed during the explosion of mixtures of coal gas and air contained in a closed vessel. Experiments show that only 90 per cent of the coal gas is burnt by the time the maximum pressure is reached, and it is estimated that were it possible to check all heat loss and burn all the gas within the explosion period the maximum rise of pressure would be increased by 14 per cent in the case of a 15 per cent mixture of coal gas and air and by 31 per cent in the case of a 9.7 per cent mixture.

In the second section after-burning in a gas-engine cylinder is discussed. It is inferred that with normal ignition only about 70 per cent of the fuel charge is burnt at the moment indicated by the peak of the indicator diagram, and there seems little doubt that incomplete combustion ranks equally with increasing specific heat as a primary cause limiting the maximum pressures developed in gas engines. The distinction between inflammation and combustion is emphasized, and it is suggested that with normal ignition setting the maximum pressure occurs more or less in the neighborhood of complete inflammation. In strong mixtures which give vertical explosion lines in the indicator diagrams, the bulk of the after-burning appears to be completed in the early stages of the expansion stroke, owing to the fact that the rate of change of volume is small in this epoch. Consequently, in strong mixtures after-burning does not affect the thermal efficiency very much. In the case of

weaker mixtures giving sloping explosion lines the rate of change of volume after the maximum pressure is reached becomes fairly rapid, and after-burning continues for some considerable distance down the expansion line. The thermal efficiency is therefore considerably affected both on account of slow inflammation and on account of after-burning. The conclusion is reached that the defect of the actual efficiency of an engine from the ideal variable specific-heat efficiency is to be attributed mainly to heat flow from the working fluid into the cylinder walls when it is working on strong mixtures and mainly to slow inflammation and after-burning when it is working on weak mixtures. The possibility of speeding up after-burning is discussed and suggestions are put forward for a research directed to this end.

In the third section it is shown that the curve prepared by the British Association Committee on Gaseous Explosions connecting the internal energy of a typical gas-engine mixture with its temperature requires modification at the higher temperatures. Assuming the correctness of the curve at the lower temperatures, a modified curve has been prepared which gives at 2000 deg. cent. a value for the internal energy about 4 per cent less than that given by the British Association Committee.

In the fourth section it is shown that the heat loss in any given engine working at a constant speed may be calculated approximately by means of the formula $KT^2_{max.}$, in which K is a constant for the given engine and $T_{max.}$ the absolute maximum temperature developed on explosion of the charge. It is also shown that, although the heat loss by conduction per unit area of wall surface at any given gas temperature is independent of the dimensions of the cylinder, the loss by radiation per unit area increases greatly with the dimensions. The reason for the unreliability of the large gas engine is thus made clear. (*Engineering*, vol. 113, no. 2932, Mar. 10, 1922, pp. 281–284, 2 figs., *t.A*)

HEAVY-OIL TWO-CYCLE GARUFFA MOTOR. Description of what is claimed to be an extra light heavy-oil aeronautical engine based on the Diesel cycle. It is stated that it can be built with stationary cylinders disposed starwise, in V or in a single row. The type especially designed for aeronautic use consists of nine cylinders starwise and it is said that one such motor worked on the testing stand for 28 hours and without interruption, notwithstanding the fact that the weight of the motor is only 800 gr. (1.76 lb.) per horsepower.

The Garuffa motor has no valves but is provided with ports, intake and exhaust, which are opened and closed by the piston. Fuel injection is secured by a direct-acting atomizer. It begins a little before the piston reaches the dead center and continues for a little while afterward, thus giving a cycle composed of an explosion phase followed by a gradual combustion phase. The atomizer is designed with the idea of breaking up the liquid as much as possible, partly by means of passing it through a series of capillary holes in the cylinder and also by applying pressure directly to the fuel. In this case the single pump gives a gage pressure of from 7 to 10 atmos. in all the cylinders. (*L'Aerophile*, vol. 30, no. 3–4, Feb. 1–15, 1922, pp. XVIII–XX, 4 figs., *d*)

SOME ASPECTS OF AIR-COOLED CYLINDER DESIGN AND DEVELOPMENT, S. D. Heron. An extensive paper reviewing some of the salient points arising in the design and development of the modern high-output air-cooled cylinder, and based to a large extent upon the work of previous investigators.

The problems of an aircraft cylinder of approximately 40 b.hp. are dealt with primarily, but some aspects of automobile-engine cylinder design are considered.

The first point treated is the heat to be dissipated, this being followed by a consideration of how to secure an even temperature distribution in the various parts of the cylinder. Cooling by a direct air blast and by conduction is discussed, the importance of removing the heat from the cylinder at the point where it is given to the head, the ports and the barrel being particularly emphasized. The effects of mixture strength and cooling-air supply upon the cylinder temperature are commented on, the text being supplemented by a number of tables. Methods of finning different forms of cylinder, the cooling surface required; the effect of the compression-ratio on the output, fuel consumption and wall temperature; cylinder materials; types of cylinder, with a summary of the advantages and disadvantages of the different forms of construction, valve-seat inserts in aluminum cylinder heads; exhaust-valve cooling; and valve gears, all receive attention.

The conclusions reached are that (*a*) successful air cooling is not limited to 50 b.hp. per cylinder; (*b*) fragility of the fins is a disadvantage of air cooling; and (*c*) the compromises necessary in the design of air-cooled cylinders have been made at the expense of the cooling efficiency.

The effect of the position of the spark plugs on the power output and the fuel consumption is discussed in an appendix and the use of two spark plugs located on a common horizontal axis that passes through the vertical axis of the combustion chamber in such a position that neither plug can project a flame wave against the exhaust valves is commended. The influence of gas velocity through the valves on the performance of an air-cooled engine is the subject of a second appendix. In this, as throughout the paper proper, numerous illustrations and tabulations of test results supplement the text. (*The Journal of the Society of Automotive Engineers*, vol. 10, no. 4, pp. 231–260, 35 figs., *el.A*)

MACHINE PARTS

Tangent Rack Gearing

HOTCHKISS-TAYLOR SYSTEM OF TANGENT RACK GEARING. Investigation of system of gearing in which the rack is arranged in a plane tangential to a cylinder as shown diagrammatically in Fig. 9. The basic gear form of this system is a ground wheel, the teeth of which are involute curves in a plane normal to the axis of the crown wheel. Fig. 9 shows the crown-wheel involute-curve teeth and to

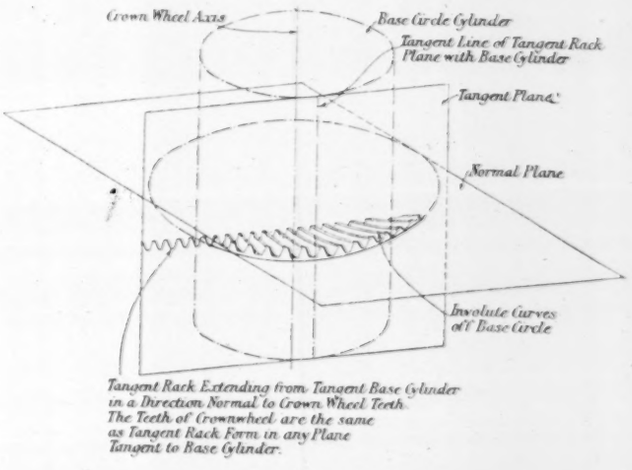

Crown Wheel Axis
Base Circle Cylinder
Tangent Line of Tangent Rack Plane with Base Cylinder
Tangent Plane
Normal Plane
Involute Curves off Base Circle
Tangent Rack Extending from Tangent Base Cylinder in a Direction Normal to Crown Wheel Teeth. The Teeth of Crownwheel are the same as Tangent Rack Form in any Plane Tangent to Base Cylinder.

FIG. 9 HOTCHKISS-TAYLOR SYSTEM OF TANGENT RACK GEARING

the left an extension representing the tangent rack of similar tooth profile.

The original article shows modifications of the same system, for example, the spiral bevel and the double helical bevel, and it is said that it is possible to produce bevel sets with non-intersecting axes.

In the tangent rack system any gear whether cylindrical or conical can be meshed with any other provided it is conjugate to the basis tangent rack crown wheel, and base circle or normal pitches are equal. The end thrust with this system of gearing is small in the case of crown wheels, and practically nil in the case of the pinions, being due to the rack-section pressure angle only, so that heavy thrust bearings are not required. For tangent involute worm gears it is desirable to employ a fairly high pressure angle, in order to mitigate the interference which would otherwise occur arising from the curvature of the crown-wheel teeth. The spiral of tangent bevel gears is involute, and in action the load component of the torque is applied tangentially to the base cylinder at any position of engagement of the pinion teeth with the crown wheel. (*Engineering*, vol. 113, no. 2935, Mar. 31, 1922, pp. 400–401, 10 figs., *d*)

MANGANESE BRONZE FOR VALVE STEMS, Wm. R. Conard, Mem. Am.Soc.M.E. The author believes that the best bronze for valve

stems is that which has the characteristics of high yield point or elastic limit, moderate ductility, and high ultimate strength, but not more than 100 per cent higher than the yield point.

This is comparatively easy to obtain as there are bronzes which have a yield point of not less than 40,000 lb. per sq. in., an ultimate strength of 60,000 to 70,000 lb. per sq. in., an elongation percentage of 10 in 2 in. and a reduced-area percentage of 10.

To overcome the causes of failures of valve stems as far as possible, the calculations for stem diameter should be based on the following:

Allowance for the fact that the metal at the base of the thread does not have as great a strength as near the surface or the top of the thread; a further allowance for the use of tools for operating, which will exert greater stress than the usual tool used; together with allowances for friction due to corrosion or sediment in the water, and other factors mentioned earlier, of weight of mechanism, friction of gates and seats in operation, and friction in stuffing box, control the area at the base of the thread, and also that a liberal allowance should be made the governing feature for factors of safety, and the metal should have a high yield point, a fairly high ultimate strength, and moderate ductility.

In order that the physical qualities of the bronze may be known and kept uniform, it is very important that frequent tests be made. The proper way to get the pieces for testing so as to have them as truly representative as the stems themselves, is, where the stem is cast and large enough to do so, to have the piece for testing cast attached to the actual stem, and where the stem is of a size to make this impossible the test piece should be cast in the same heat and in the same flask as the stems. In the case of hammered or forged stems, the test piece should be a prolongation of one end of the stem reduced to a cross-section that will show a close approximate of the metal in the stem itself. It is unnecessary to go into the details of the methods of making the physical tests.

For smaller and medium-sized valve stems up to and including those for, say, 24-in. valves, a cast stem is entirely proper, but for stems for valves 30 in. and larger they should be of forged manganese bronze. Forging adds very little to the cost and adds some to the physical qualities, but its main value lies in that the forging on stems of heavy cross-section makes the metal homogeneous and of uniform texture throughout, makes a perfect metal for the threads and eliminates the uncertainties that are apt to be present in the case of large castings, where the central section is subject to different cooling stresses than the outer section. (*Journal of the New England Water Works Association*, vol. 36, no. 1, pp. 32–36, and discussion pp. 37–39, *p*)

MACHINE SHOP

Hand- and Machine-Lapped Surfaces as Seen Through a Microscope. The production of highly efficient lapped surfaces is of considerable importance in precision-gage manufacture. From an investigation carried out by a manufacturer of gages by means of photomicrographs it would appear that there is a material difference between hand-lapped and machine-lapped surfaces; the latter not only appear to be smoother but the scratches on machine-lapped surfaces are short and either parallel with the axis of the plug or slightly inclined. On the contrary, scratches on hand-lapped gages extend diagonally around the work, due to the use of ring lap which is given a traversing movement. In lapping machines the finer surfaces are obtained by performing the lapping operation between two flat cast-iron plates having very true surfaces and operating in such a way that the plugs receive a combination of rolling and sliding action.

Among other things, it is stated in the article that lately a modified process has been developed for lapping of true cylinders between flat plates, of which no details are given though it is stated that by this means a number of cylindrical gages for other parts are lapped simultaneously and by systematically and repeatedly transposing them and averaging the errors the entire lot is finished to a true cylinder form to within, say, 0.00001 in. or less. (*Machinery*, vol. 28, no. 8, Apr., 1922, pp. 638–639, 6 figs., *dc*)

Production Figures on Locomotive Fusible Plugs. It is said that in England the capstan lathe was recently successfully used in connection with the production of locomotive-boiler fusible plugs. The special-tool layout for these plugs is shown in the original article and comprises, among other things, a starting and facing drill, a straight-flute drill, a double-knee tool holder with pilot, a taper boring bit and a special taper running steady. The machine is fitted with a chasing-arm attachment and the sequence of operation is as follows:

Grip plug on square end with special jaws in two-jaw chuck.

Start drill and face end of casting to length, with special starting drill and holder.

Drill-tapping hole with straight-flute drill in drill chuck.

Turn external diameter of plug (parallel) to remove scale, with double-knee tool holder, cut being steadied by plain pilot fitting in hole already drilled.

Open out end of hole with taper boring bit.

Steady with special taper plug in standard running center steady, and form external diameter to correct taper with wide form tool on rear of cross-slide.

Retain running center steady in operative position and cut thread with chasing tool in swing-over chasing arm. Approximately six cuts are necessary to cut the full thread.

Tap center hole, using $^5/_8$-in. tap in standard releasing tapholder.

Remove from chuck.

The maintainable production time on this sequence of operation is 1 min. 15 sec. per plug, or 48 plugs per hour. It should be realized that this production time applies to the complete machining of the plug from the rough casting, screwing it both internally and externally to the usual standard gages, so that no further machining work is necessary. (*British Machine Tool Engineer*, vol. 2, no. 14, Mar.-Apr. 1922, p. 452, *p*)

MEASURING APPARATUS (See Railroad Engineering)

MOTOR-CAR ENGINEERING

Nitrogen as a Tire-Filling Material. The Roland Machine Construction Co. of Berlin has experimented with rubber tires filled with pure oxygen and find that they deteriorate with great rapidity under these conditions. As this tended to point to the possibility that it was oxidation phenomena that caused the destruction of the tires, experiments were carried on in the opposite direction, namely, with oxygen-free, that is, inert materials, in particular, nitrogen as tire filler. The results have been very interesting. Nitrogen-filled tires maintain their hardness for over a year in cars driven over thousands of miles on open roads. The loss of nitrogen proved to be surprisingly small and the state of the rubber far better than in air-filled tires. Similar tests have been carried out by the Continental Caoutchouc and Rubber Co. (German) and have given substantially similar results. The explanation offered by Prof. K. A. Hoffmann is based on the sensitiveness of rubber to oxygen and particularly ozone. A contributing factor is the oxidation of the sulphur contained in vulcanized rubber.

It would appear that if the advantages from filling tires with nitrogen instead of air are as great as would follow from the above described experiments, the question of added cost would not be of material importance. (*Motor und Auto*, vol. 19, no. 5, Mar. 15, 1922, pp. 73–74, *epA*)

Mercedes Car with Supercharged Engine. In the Targa Floria race held on April 2, 1922, on the island of Sicily, the Mercedes car covered 269 miles in 6 hr. and 50 min. at an average of 39.3 miles an hour. The speed does not appear to be large unless it is taken into consideration that the race was around a mountain side with a number of bends and holes, testing the endurance of both cars and drivers to the utmost.

The Mercedes car used a supercharger about which very few particulars were given out at the race. The engine had four valves per cylinder driven by a couple of overhead camshafts in aluminum housings. The camshaft drive was by vertical shaft and bevel gearing at the rear, with the magneto also at the rear, and the spark plugs placed in the center of the cylinder head. The design makes it possible to throw the supercharger into and out of engagement as desired. Nothing definite has been published about the power

output of the engines, but the author learned on reliable authority that they run up to 5000 r.p.m. (*The Autocar*, vol. 48, no. 1382, Apr. 15, 1922. The entire article covers pp. 622–628, illustrated; the part referring to the Mercedes engine described in the abstract, pp. 627–628 with no illustrations, *dA*)

POWER-PLANT ENGINEERING (See Also Air Engineering)

Setting Valves of Marine Engines by Elliptical Diagram

SETTING VALVES BY ELLIPTICAL DIAGRAM, Arthur O. Gates. Description of a method employed on marine engines. The common method of setting valves on marine engines after an overhaul is by the use of rods or trams which have marked upon them the positions of the valve points and the openings into the cylinder casting. One of these rods is held upon the outside of the cylindrical casting; the other is set upon the end of the valve at some designated point. The engine crank for that cylinder is brought to dead center and the valve adjusted to the designated lead. The process is clumsy as the trams may be easily lost and there is always a chance for uncertainty in the measurement and adjustment of the lead.

In January, 1918, the U. S. S. *Marblehead* was released from the Mare Island Navy Yard after a short overhaul of her engines which necessitated resetting of the valves. On the run down the California coast it was found that the valves were not properly set and the writer was assigned to the duty of planning and making the proper changes. He did this by the application of the elliptical diagram.

The diagram given in Fig. 10 is for one low-pressure cylinder and is reduced to about half size. In the original plotting the actual movement of the valve was shown at all points, while the piston movement was plotted to scale. After the plot was made the distance that the valve was open at the top when in its lowest position for one block setting was measured upon the diagram and a horizontal line drawn through this point. The valve traveled upward this amount and closed the port. This is the point of cut-off. The valve continued to travel upward and after a distance of about $1^1/_2$ in., as may be calculated from the drawing of the valve and ports, the port to the bottom end was closed; this determined the compression point of the bottom end. Travel continued for about $1^1/_8$ in. and the release of the top end occurred. Then, as the valve traveled upward $1^9/_{16}$ in. further, steam was admitted to the bottom cylinder and the valve continued upward until the port opening of the bottom end became $2^3/_4$ in. by the old setting and 3 in. by the new. These were measurements calculated from the drawing as there was no way (or need) to get under the valve without dismantling the engine.

Following the valve on its return stroke, on closing the port for cut-off of the bottom cylinder the valve had of course traveled back the $2^3/_4$ in. or 3 in. mentioned above; then down $1^9/_{16}$ in. to compression of the top end; then down about $1^1/_8$ in. to release of the bottom cylinder, then $1^1/_2$ in. down to admission to the top end, and on to the end of the stroke of the valve, which gave a full valve opening of $2^3/_{16}$ in. by the old setting, and $1^{15}/_{16}$ in. by the new.

The other curves were obtained by changing the block setting, screwing it in the number of inches indicated by the number on the curve. The valve gear of this engine was of the Stephenson link type using the double bar link of a type common in marine practice, and the control of the expansion of the cylinder was obtained by adjustment of the position at which the rod connecting the Stephenson link was secured to the reversing gear. An adjustable block at this point determined the point of application of the eccentric motion to the valve stem.

From these diagrams indicator cards may be constructed. Among the points brought out by this diagram is the relative unimportance of lead. With a new setting the lead at the top end (bottom of diagram) measures about $^5/_{16}$ in. and for the bottom end $1^3/_{16}$ in.

The author believes that this diagram could be applied to the settings of valves of a Corliss engine by plotting the movement of the wristplate measured along the arc of the pins of the rods connecting to the valves; on some engines two sets of diagrams would be required—one for the steam valves and one for the exhaust valves. The theoretical indicator diagram which has been added below the valve diagram is intended to show how the adjustments would affect the points in the card, and without regard to the pressures, clearances and distribution between the different cylinders. (*Power Plant Engineering*, vol. 26, no. 8, Apr. 15, 1922, pp. 410–413, 1 fig., *pA*)

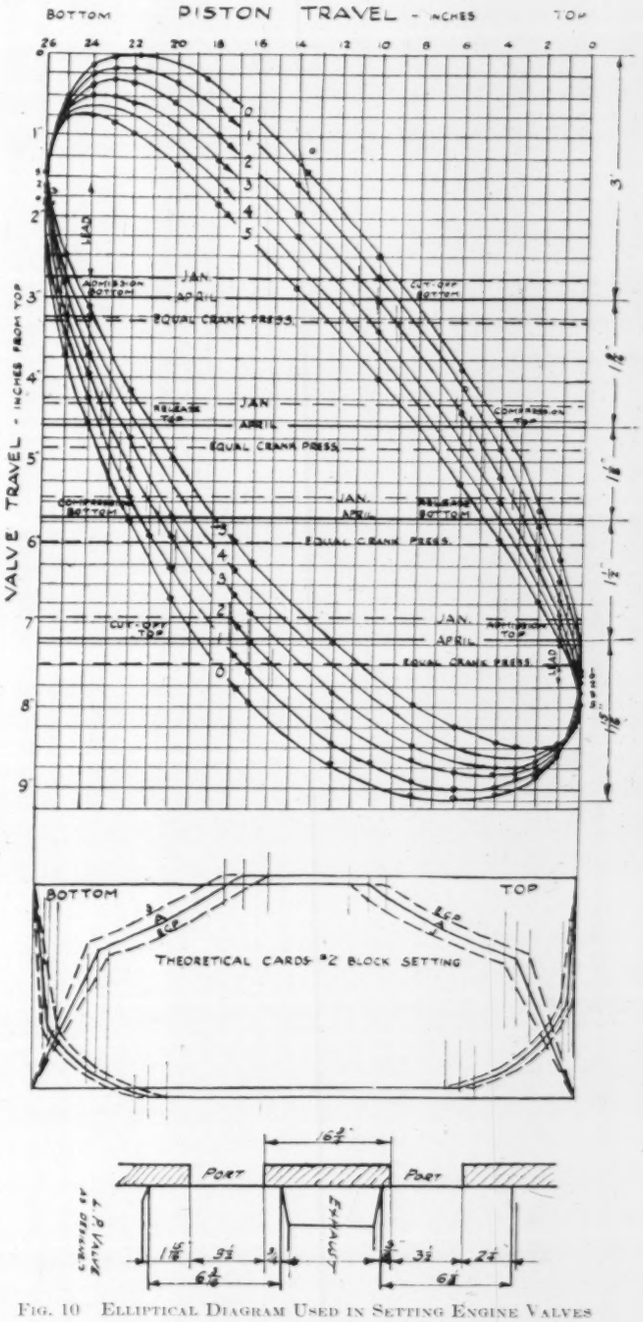


FIG. 10 ELLIPTICAL DIAGRAM USED IN SETTING ENGINE VALVES

PUMPS

Tests on Impact Losses of Water Jets

IMPACT LOSSES OF JETS, J. J. Burnell. Description of tests and experiments on water jets from centrifugal pumps carried out at the pumping station of the State Rivers and Water Supply Commission of Victoria, Australia. The article describes fully the method of carrying out the tests.

The first set of experiments was designed to determine the loss of kinetic energy in the jet due to varying deviations. The results obtained show that the loss of velocity due to sudden deviation of the jet through any angle up to 90 deg. is practically negligible. The greatest loss of kinetic energy occurs between 20 and 25 deg.

deviation and is of the order of 2 per cent only. It was observed, however, that for angles of deviation of 10 deg. and upward a certain portion of the total flow took place along the vein in the direction opposite to the main flow. The results are given in Fig. 11.

The three curves in Fig. 11, in which the proportion of back flow is plotted against the deviation of the jet in degrees, show a curious inflection extending from 15 to 30 deg. Such an inflection might be suspected as due to experimental error were it not very similar in all three curves, and did not correspond almost exactly to an inflection in the curves purposely shown below, in which the kinetic energy after impact or deflection is similarly plotted against the deflection of the jet in degrees.

Formulas for the relative proportion of back flow to forward flow are given in the original article, and are compared with the results obtained by Prof. A. H. Gibson. (Hydraulics and Its Applications, p. 368.)

While the experimental results do not fall exactly on this curve they do follow it more or less closely, and conform generally to the

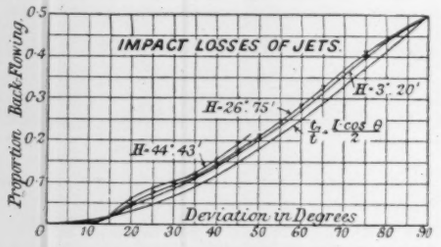


Fig. 11 Impact Losses of Water Jets Due to Deviations

law it expresses. From 0 deg. to 10 deg. there is considerably less back flow than indicated by the theory; exact agreement occurs at about 15 deg., beyond which the back flow is always greater than indicated by the theory. Above 15 deg. the discrepancy is greater the greater the head. In practice, however, the results between 0 deg. and 15 deg. are those of greatest importance. The proportion of back flow up to 10 deg. deflection is so very small—about one part in 1000—as to be quite negligible in ordinary practice. For 15 deg. it may be taken as 1.8 per cent.

Friction losses in bends were also investigated and were in general found to be quite small. (Paper before the Melbourne Division of the Institution of Engineers, Australia, Oct. 26, 1921, abstracted through *Engineering*, vol. 113, no. 2935, Mar. 31, 1922, pp. 404–405, 4 figs., *e*)

RAILROAD ENGINEERING (See also Machine Shop and Varia)

Studies on the Design for a 150-Lb. Rail Section, W. C. Cushing. The crux in rail design is the width and depth of head necessary to perform its work with safety and economy. There are two sets of conditions which determine the designs of rail sections, the sections being known as types RA-A, and RA-B. The one set of conditions is heavy tonnage carried in a territory of crooked alignment and steep grades, while the other set is centered in territory with better alignment and grade with the duty of carrying traffic of more moderate tonnage.

After all rail design had been brought to these two general types, the Rail Committee of the American Railway Engineering Association, after years of study, succeeded in having the set of designs known as the RE rail sections accepted as recommended practice, with weights varying from 100 to 140 lb. Lately a 150-lb.-per-yard section has been designed and recommended to the Rail Committee for presentation to the Association. While it has not yet been considered by the Rail Committee, it is of interest.

It has been proved many times that a heavy deep head is necessary for bearing safely and economically all heavy tonnage in territory of crooked alignment and steep grades. This has been confirmed practically by tests on the Pennsylvania Railroad. The first thing, therefore, to decide upon is the quantity of metal for the head deemed essential for carrying the load-bearing relation to wheel thread and allowing for considerable wasting away of metal before loss in strength requires removal. It is then necessary to decide upon the suitable thickness of base to avoid fractures and make a proper balance of metal with the head so as to render the problem of rail straightening easier by a medium punishment of the metal. It is next desirable to have proper relation between the thickness of web and its height in order that the column should be suitably proportioned.

Actually, the practice of the companies principally in the northeastern part of the country with great density of traffic carried over crooked alignment and steep grades leans toward rail design with heavy head and moderate height, while the western and southern companies having less dense traffic and larger percentage of tangent alignment with easy curves favor the thin head and great height.

As regards the cost per mile per unit of weight (10,000,000 tons) of traffic borne by the different weights and sections of rail, there is no reliable information, but from careful observations it has been estimated that the 130-lb. rail on the Pennsylvania System in its heavy-curvature districts outlasts by $2^1/_2$ times the 100-lb. section, and is worth 23 per cent more in reduced maintenance.

The conclusion to which the author arrives is that the time has not come yet for making any change in the present RE sections, especially as the 100-lb. and 130-lb. sections are now rolled. (Paper before the Annual Meeting of the American Railway Engineering Association, abstracted through *Railway Review*, vol. 70, no. 13, Apr. 1, 1922, pp. 447–449, 3 figs., *g*.—The author is Engineer of Standards, Pennsylvania Railroad System)

Test of Siphon Locomotive on Spokane International Railway. The Spokane International Railway in operation over its main line has to deal with conditions of local work and severe grades of such a character that it proved to be difficult to maintain the schedule with 10-wheel locomotives having cylinders 19 in. by 24 in. and 22,000 lb. tractive effort handling 5-car trains. This situation is still more aggravated by the poor quality of the coal and the limited grate area.

In an effort to remedy these conditions the railroad decided to install a Nicholson thermic siphon (Compare Mechanical Engineering, March, 1919, p. 284) on one of these passenger locomotives and to test this locomotive in comparison with another locomotive of the same class having a plain firebox.

The original article states the main reasons why the thermic siphon was selected in preference to other devices, among these factors being its ready adaptability to the locomotive and low maintenance charges, since the siphons become virtually a part of the firebox and necessitate no repair work outside of the ordinary firebox maintenance. Moreover, the application of this device has proved to be a relatively inexpensive means of increasing locomotive capacity and efficiency. The original article gives some data on the method of applying a single thermic siphon to the narrow firebox of the 10-wheel type locomotive.

The results are given in the original article in the form of curves and tables. From these it would appear that the application of the thermic siphons increased the tractive effort and cylinder horsepower, the former from 22,000 to 31,160 lb. and the latter from 1202 to 1264 hp. In addition to this, decidedly better firebox and boiler conditions have been obtained. The increased boiler and cylinder capacity of the siphon-equipped locomotive made it possible to handle the same train with greater ease, while the additional heating surface and improved water circulation caused by the siphon made a marked improvement in the steaming capacity of the locomotive. Maximum steam pressure was maintained at all times and the boiler was fully supplied with water during all of the runs with the siphon-equipped locomotive, while with the non-siphon locomotive it was necessary to trade water for steam in hard places. The coal consumption per sq. ft. of grate area was reduced to 133 lb. as compared with ordinary consumption which frequently exceeded 160 lb., and as a result of these tests the Spokane International Railway has ordered siphon equipment for a freight locomotive, which will enable the railway to increase the diameter of the cylinders on this locomotive 1 in., thus materially increasing the tractive effort and cylinder horsepower. (*Railway Review*, vol. 70, no. 15, Apr. 15, 1922, pp. 522–524, 3 figs., *ce*)

Ramsay Condensing Turbine Electric Locomotive. The locomotive was built for the Ramsay Company at the works of

Sir W. G. Armstrong, Whitworth & Co., Ltd. In this locomotive a condenser of novel form is applied in conjunction with the steam turbine. Superheated steam is expanded down from boiler pressure to a vacuum of 27½ in., the condensate being drawn off from the condenser by a rotary extracting pump and returned to the hot well, from which a feed pump delivers water into the boiler, thus completing the cycle.

The front engine, both as regards the boiler and underframe, differs but little from accepted locomotive practice, except that the reciprocating engine is displaced in favor of a turbo-generator made by the Oerlikon Company, of Zurich. The main turbine is of the impulse pressure compounded multi-stage type, connected through a flexible coupling to a three-phase generator capable of sustaining a 25 per cent overload for half an hour. This generator is separately excited by an auxiliary turbine-driven direct-current generator. The three-phase generator supplies power to four three-phase slip-ring motors arranged in two groups on the front and rear parts of the locomotive, respectively. The two motors of each group are bolted to a common stretcher carrying a countershaft, to which the motors are geared. The power is then transmitted from the countershaft to the six driving wheels on each part of the engine by coupling rods in the ordinary manner. Each of these motors is capable of developing 275 hp.

The rear engine contains the coal bunker and cooling-water tank, as well as the condenser and its appurtenances. The condenser forms one of the novel features of the engine. It is of the evaporative type supplied with air by a fan at the rear of the engine. The steam tubes of the condenser are arranged in the form of a cage, which is caused to revolve in water at slow speed and through which the air is impelled by the fan in a radial direction over the tubes. A flexible pipe between the two portions of the engine connects the turbine exhaust to the condenser.

The boiler is hand-fired and is fitted for forced draft. The driver operates the locomotive by means of a master controller placed in the cab. (*The Engineer*, vol. 133, no. 3456, Mar. 24, 1922, pp. 328–329, 2 figs., *d*)

DYNAMOMETER-CAR TONNAGE TESTS, O. O. Carr. The article is based on an experience of several months on a dynamometer car engaged in carrying out tonnage-rating tests on the Illinois Central Railroad.

One of the conclusions to which the author arrives is that office ratings of engines are entirely unreliable. Actual test observations show that train-resistance formula calculations are at variance with different track conditions. For instance, an 85-lb. steel track laid 12 years and worn down pretty well on a gravel bed through a cut on a 26-ft. grade will stall an engine loaded to maximum, and yet the same engine will have no difficulty whatever in going over a 26-ft. grade, 90-lb. rail, rock-balanced bed, the difference being due to the greater track resistance of the former.

Among the important factors affecting tonnage capacity of freight trains are mentioned individual locomotive characteristics and personal characteristics of the engine crews, as well as the kind of cars and their loading.

A comparison of results shows false economy of reducing tonnage. There is no economy in giving engines a 100 per cent train over a 130-mile district where there are a number of heavy grades to contend with and keep a train on the road 14 or 15 hr., but it may be profitable to keep a train on the road 12 hr. with a 100 per cent loading if this can be done without impairing the coöperation of the train crew in getting over the road.

Large train loads mean not only decreased number of train units running in both directions but decreased number of locomotives to handle and maintain, enabling more expeditious train movement and a corresponding increase in the capacity of the railroads. (*Railway Review*, vol. 70, no. 13, Apr. 1, 1922, pp. 451–455, *pA*)

WATER TREATMENT AS AFFECTING LOCOMOTIVE PERFORMANCE, W. A. Pownall. This article is based on the experience of the author for the past ten years on the Wabash Railway, where he occupies the position of mechanical engineer. There soda-ash treatment is being used and favorable results secured.

As regards the cost of water treatment, the waste of fuel and water in blowing off is possibly the major part, but there is no guesswork as to this item of expense. On an ordinary division where the treatment averages 0.6 lb. of soda ash per 1000 gal. of water, the fuel waste in blowing off is approximately 1.1 per cent of the coal used, and the total cost of the coal and water wasted is about $0.026 per 1000 gal. The average cost between washouts will be less than this since very little blowing is done after washout until the concentration has reached the foaming point. Under ordinary conditions it is usually cheaper to blow out a boiler than to wash it out at the terminal, but the cost of blowing out is much more than offset by fuel saving from clean heating surfaces and by other attendent benefits.

The writer emphasizes the fact that it is very essential to the successful use of treated water to have the support of the enginemen.

Some practical suggestions as to the details of operation are offered in the original article. In particular, it is stated that on the Wabash the foaming point is reached when the concentration of dissolved solids is about 240 parts per 100,000. (*Railway Mechanical Engineer*, vol. 96, no. 4, Apr., 1922, pp. 191–192, *p*)

STEEL RAILS EMBRITTLED BY WELDING BONDS. According to tests made by a private laboratory it was found that decided weakening of steel T-rails is produced by attaching electric rail bonds by welding.

On some lines of the Mexico City Street Railway System loss of exposed copper bonds by theft became serious enough to make a concealed bond desirable. A bond was therefore designed to fit under the standard splice bar passing around the bolts and was to be attached to the rail web by means of electric arc welding of the steel facing to the rail metal.

In tests made to determine whether this method of attaching a bond affected the strength of the rail, samples were submitted to comparative drop tests. In these tests the unbonded specimens broke on the third and fifth blow, where the bonded specimens drop on the first blow. Moreover, quite abnormal shapes of fracture resulted in the case of the bonded specimens. It is believed, however, that attaching the bond to the head or base of the rail by welding instead of to the web may not be injurious, owing to the more massive shape of the sections affected. (*Engineering News-Record*, vol. 88, no. 13, Mar. 30, 1922, pp. 524–525, 2 figs., *d*)

SPECIAL PROCESSES

THE MANUFACTURE OF BRASS FORGINGS, C. T. Roder. Description of a process which is also called die pressing or hot forging. The method of forging brass was initially developed in Germany and Great Britain about 1900. In this country it did not reach the stage of commercial-development until after the United States went into the war. The process requires the highest type of skill in the art of forging.

A brass pill or slug cut off from extruded rod is heated in a specially constructed furnace open at both ends to a cherry-red heat (approximately 1300 deg. fahr.), though the temperature varies with size and construction of the piece to be forged. The pill is then fed into the press. The ordinary small shapes (up to 4 in. in diameter) are forged under 400,000 lb. pressure; for larger pieces presses are used having capacities up to 600 tons. With the continuous operation of a press and a skillful operator one press can average from 5,000 to 10,000 forgings per day.

Small forgings of simple design where the metal does not have to flow far are produced in a single-acting press. Where the shape is very intricate and where it is necessary for the metal to flow over a long distance, double-acting presses are used.

Brass forgings are 80 per cent stronger than sand castings and show a tensile strength and yield point, respectively, of 55,000 and 28,000 lb. per sq. in. and an elongation of 30 per cent, though the writer knows of instances where forgings have been made with a tensile strength of 105,000 lb. per sq. in., this being accomplished by a special mixture of metals. Dimensions can be held to 0.005 in. on diameters and 0.010 in. on length, in addition to which the metal is easier to machine than sand castings.

The original article gives some practical suggestions as to die design and expresses a belief that the forging process will extend in its applications. (*The Iron Age*, vol. 109, no. 13, Mar. 30, 1922, pp. 857–858, 2 figs., *dp*)

STEAM ENGINEERING (See also Air Engineering and Power-Plant Engineering)

Laws of Similarity as Applied to Steam Turbines

The Size Factor in Steam Turbines. Laws of similarity have been found to be applicable to reciprocating steam engines and it is generally accepted that while the output of engines run at corresponding speeds increases as the square of the scale, the weight increases as the cube, and hence the weight per horsepower developed should increase directly as the cylinder diameter.

The corresponding law of similarity applies to steam turbines, with the distinction, however, that while in engine practice the dead weight carried by the shaft is commonly small compared with the load imposed by the steam pressures or by the inertia of the moving parts, in a steam turbine the bending stresses are entirely due to the weight of the rotor which increases as the cube of the scale. Hence, with geometrically similar rotors the bending stress on the shaft will increase in direct proportion to the scale, but as regards output the same rule applies as in the case of the reciprocating engine, namely, that at corresponding speeds the output increases as the square of the scale.

The effect of change of scale on the efficiency of geometrically similar turbines does not appear to have received much study as yet, and evidence is much less direct than is desirable.

A large turbine is not generally a replica of a small one to a larger scale, a condition of affairs for which commercial considerations are largely responsible. The cost of valves, governor gear, oil pumps, tachometers, gages and other accessories forms a far greater proportion of the total cost of a small turbine than it does of a large one. Some interesting information on this head was given in a paper read before the Rugby Engineering Society in 1913 by J. P. Chittenden, from which it appears that in the case of a turbine rated at 500 kw. the cost of accessories amounted to 45 per cent of the total. With an output of 10,000 kw. this figure was reduced to 30 per cent. Hence small turbines have in general been constructed with a lower ratio of blade speed to steam speed than large ones, so as to keep down the cost per kilowatt of rated output.

For this reason the data for a direct determination of the effect of size on the efficiency hardly exist. In actual fact the published test data for small turbines and for large ones plot down very fairly on the same efficiency curve, but this constitutes by no means conclusive evidence that the effect of size on efficiency is unimportant, since for the reasons stated the large turbines and the small ones correspond to different regions of the curve and are not therefore similar turbines run at equivalent speeds.

That the test results do in general plot down with fair regularity is very satisfactory from the practical standpoint as it simplifies the work of the designer, but it is not what would have been anticipated from general considerations, almost all of which would lead us to anticipate that the element of mere size should have a by no means negligible influence on turbine efficiency. For example, from the theory of dimensions it appears that in geometrically similar turbines run at corresponding speeds the waste of thermodynamic head in guide-blade and bucket friction should vary as d^{-n}, where n is unknown, but is in all probability a small positive fraction, and d denotes some characteristic dimension of the similar guide blades. In the actual practice of today, however, the dimensions of the guide blades and buckets hardly increase as fast as the diameter of the turbine, and this will tend to reduce the difference between the relative steam friction losses in large and in small machines.

The question of relative clearance losses is a difficult one. In general engineering work clearances vary rather as the square root of the scale than in direct proportion thereto, and if this rule held in steam-turbine practice the larger the machine the smaller proportionately should be the losses by leakage. On the other hand, if the main proportions of the machine were strictly geometrically similar, the deflection of the shaft would increase directly as the scale and the limiting value of the clearances to which it is practicable to work must be a fraction of the shaft stiffness. If we attempt to obtain further light on this matter by a comparison with experience, we are again confronted with the lack of data which are fairly comparative, since in general the smaller machine will have fewer stages, and thus be relatively shorter than the large one, and the stiffness of shaft increases very rapidly as its length is reduced.

The subject of waste of energy in disk friction and fan action is also discussed largely on the basis of a paper by Eskil Berg read in 1919 before The American Institute of Electrical Engineers. (*Engineering*, vol. 113, no. 2935, Mar. 31, 1922, pp. 395–396, editorial article, *g*)

TESTING AND MEASUREMENTS

New Theory of Tensile Strength of Metals

Tensile Strength of Plastic Metals, Dr. Friedrich Koerber. This paper presents a method for computing the tensile strength of plastic metals from the curve of "true" stresses. It also discusses the mechanism of the tensile rupture test and proposes a theory of tensile stresses based on an assumption of slip and torsion effects of crystalline elements in the metal. Confirmation of the theory is sought for in X-ray photographs.

In tensile tests it is usual to compute the load on the basis of the initial cross-section of the test piece. The tensile stresses $\sigma = P/f_0$ computed in this manner, however, increase with increasing load up to a certain maximum value for cold tensile strength, and then fall off up to the breaking load at which the test piece ruptures. On the left-hand side of Fig. 12 is shown the stress-elongation curve as usually plotted. In this process the cross-section of the test piece decreases practically uniformly over its entire length; it is only after the maximum load has been reached that local contractions occur.

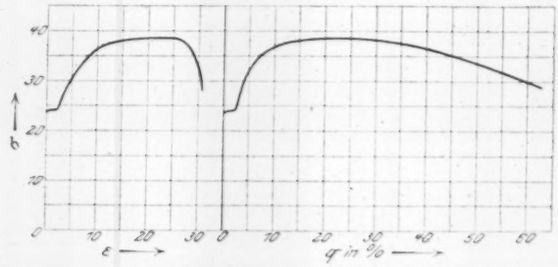


Fig. 12 Stress-Elongation and Stress-Reduction of Area Curves

On the right-hand side of Fig. 12 the variation of stress is shown for the entire test piece as a function of reduction of area at the thinnest obtaining section of the test piece. From such a curve it would likewise appear that the stress passes through a maximum value.

The stress values computed in this way do not, however, give a basis of measurement of the actual stresses produced in the test pieces by the load applied to it, and in particular it is difficult to express the physical meaning of tensile strength as the maximum load is being expressed in terms of a cross-section of test piece, which does not actually exist at the time when the maximum load is being applied.

A more complete idea of the state of stress in a material may be had by referring the load to the minimum area of cross-section in a test piece that may obtain at any given moment, which, in other words, means by computing the "true" stress $\sigma' = P/f$.

If the stress σ' obtained in this manner be considered in functional relation to the reduction of area, it will appear that in the region of the greater form variation of material these values lie very nearly along a straight line. This fact has already been observed before by the author and other investigators, and the author gives in the original article curves for pure iron-carbon alloys and technically pure copper, which illustrate the straight-line character of the stress-reduction of area curves.

In Fig. 13 the heavy line gives the ideal σ' curve. The point c shows the beginning of the reduction of area process. In the region of the greater plastic alterations of shape, the following law holds good: *The increase of stress is proportional to the alteration of shape of material expressed by the reduction of area.* If we select the initial area $f_0 = 1$, then the load or the stress σ referred to a unit of the initial cross-section of a material is a product of the "true" stress σ' and the area $f = (100 - q)/100$. While the cross-section f decreases gradually and in accordance with a straight-line law until it reaches a value of zero corresponding to a reduction of area $q = 100$,

the true stress σ' gradually rises from zero and, for the regions of greater stresses, follows likewise the straight-line law. From this it follows that the stress σ is equal to zero for those values for which σ' or f are equal to zero, and between these two values it passes through a maximum value σ_{max}. This particular value of tensile strength may be expressed by the formula:

$$\sigma_{max} = \left(\frac{\sigma'_0 + 100\,\alpha}{2}\right)^2 \times \frac{1}{100\,\alpha}$$

which permits computing the constants σ'_0 and α for the straight-line part of the $\sigma' q$ curve. The meaning of these constants may be seen from Fig. 13.

The parts referring to the theory of slip and torsion of the crystals

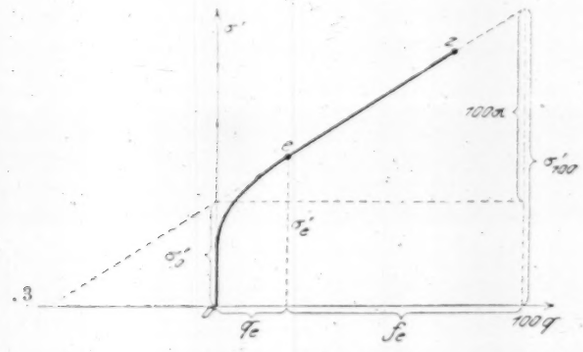


FIG. 13 $\sigma' q$ CURVE

in plastic metals cannot be reported here owing to lack of space. It is of interest, however, in view of the slip-interference theory proposed by Zay Jefferies and R. S. Archer, for which compare the abstract in MECHANICAL ENGINEERING, August, 1921, p. 543 from *Chemical and Metallurgical Engineering* (vol. 24, no. 24, June 15, 1921, pp. 1057–1067). (Abstract from the Bulletin of the Kaiser Wilhelm Institute for Iron Research (Kaiser Wilhelm Institut für Eisenforschung) vol. 3, no. 2, in *Stahl und Eisen*, vol. 42, no. 10, Mar. 9, 1922, pp. 365–370, 8 figs., *et.*A)

VARIA

LOCOMOTIVE CONSTRUCTION BY THE BRITISH GOVERNMENT. The scheme for building locomotives by the Government originated with the Woolwich Shop Stewards' Committee (in America, Walking Delegates' Committee). After the Armistice an attempt was made to introduce commercial work into the arsenal production as a means to obviate unemployment.

Under this scheme all sorts of things, such as milk churns, medals, etc., were manufactured at the arsenal, the largest thing being, however, the manufacture of locomotives. There were initially no shops or machinery suitable for this and no officials who understood the business, nor was there any guarantee that the engines when manufactured would be purchased by the railway companies. Nevertheless, under the auspices of the Ministry of Munitions huge areas of existing factories at Woolwich were pulled down, machinery was transferred at great expense to other parts of the arsenal and the new plan was laid down at a period when both machinery and materials were at almost their highest price. The total expenditure in this connection is conservatively estimated at £500,000.

Shop managers who had no knowledge of locomotive manufacture were sent to railway engineering centers to obtain it. It took some time to organize the production and when the shops were ready the market began to fall. It is still falling owing to the cheapening of labor and materials, and English railway companies will not look at the engines at the prices the Government asks for them. At one time there was a hope that the locomotives could be sold to Russia until it was discovered that the gage was unsuitable for the railway systems in that country.

The result of this adventure in Government manufacturing is not encouraging. The Government has on its hands 45 locomotives it cannot sell; it has lost £900,000 in the business and has a further loss in view; it has a large plant of a very expensive character for which in the near future it will have no use; and the benefits to labor are more than doubtful. (*Daily Metal Trade*, vol. 12, no. 77, Apr. 19, 1922, p. 7, *g*)

SOUNDPROOF PARTITIONS, F. R. Watson. Data of tests on transmission of sound through partitions, of interest in that, among other things, they present the theory of transmission of sound through a partition.

Sound may be transmitted from one side of a partition to the other in three ways: it may progress through continuous air passages; it may pass as an elastic wave length through the solid structure of the partition; or, by setting the partition in vibration, it may originate sound waves on the further side.

These actions are quite readily understood by remembering that sound consists of a series of compressions and rarefactions that progress rapidly through a medium without interruption unless they meet a new medium with a different elasticity or density. For instance, sound waves in air proceed without hindrance through air passages, such as ventilation openings in a partition. If, however, the passages are small in cross-section, as in the case of a porous material, the progress is hindered and a certain amount of absorption of the energy takes place, due to the friction set up between the vibrating air column and the sides of the pores.

In case the partition is impervious to air, the direct progress of the waves is interrupted. A thin partition is set in vibration and thus originates new waves on the side opposite the incident sound. For a thicker, more rigid partition the vibrations are smaller and a very considerable part of the energy is reflected. The transmission in this case takes place by compressional waves communicated to the solid material of the partition. The amount of energy thus transmitted is usually quite small.

In view of these considerations a soundproof partition should be as rigid and free from air passages as possible. For effective soundproofing of a group of rooms, the partitions, floors, and ceilings between adjacent rooms should be made continuous and rigid. Any necessary openings for pipes, ventilators, doors, and windows should be placed in outside or corridor walls where a leakage of sound will be less objectionable.

In case the sound is generated in the building structure, as the vibrations set up by a motor fastened to the floor, the compressional waves proceed through the continuity of solid materials. In order to stop them, it is necessary to make a break in the structure so as to interpose a new medium differing in elasticity and density. For instance, the vibrations of a motor may be minimized by placing a layer of hair felt, or similar air-filled material, between the supporting base and the floor. Where the machinery is quite heavy, footings may be made of alternate layers of asbestos, lead, and leather. Bolting through this material will reduce the insulation, because the vibrations in this case will pass easily through the bolts to the floor. The insulation should thus be left without any bridging over of the discontinuities. Air gaps in masonry will be effective if the air space is not bridged over at any point. A floor floated on sand, sawdust, or hair felt would approximate this condition. The edges of the floor should be insulated from the walls by felt or similar material.

Especial attention should be paid to the ventilation system. All effective soundproof constructions either omit entirely a ventilation system or else construct it in some special manner to avoid transmission of sound. In some buildings air is supplied and withdrawn from rooms by individual pipes that are small in diameter and extend without break from the air-supply chamber to the rooms. This results in considerable friction between the walls of the pipes and the air, with a resultant weakening of the sound waves. Without some efficient control of the transference of sound through the ventilation system it is a waste of effort to construct soundproof walls, double doors, and other contrivances for insulation.

When soundproofing a building all details should be considered with respect to the likelihood of transmission of sound. Each room, as far as possible, should be made an insulated unit by means of air spaces or air-filled materials that separate it from surrounding walls. Pipes and ventilators should be so installed as to minimize the chance of transfer of sound. Patent doors are now available that will close the door at top, sides, and bottom. In case a troublesome sound is generated in the room, it may be minimized by installing absorbing material on the walls.

The absorption of sound is an essential feature for soundproofing. Reflecting sound and scattering it still leaves it with energy. It must be absorbed; that is, converted into heat energy by friction, before it is eliminated as sound. This means that carpets, furniture draperies, etc., should be present, or if greater absorption is desired, hair felt or similar materials must be installed.

The insulation of sound is a complex problem and a successful solution is obtained only when all the possibilities of transfer of sound are anticipated and guarded against. (*University of Illinois Bulletin*, vol. 19, no. 28—same also as Bulletin 127 of Engineering Experiment Station, Mar. 6, 1922, pp. 1–178, 30 figs., bibliography pp. 77–78, *etA*)

Calculating the Efficiency of Boiler Seams, R. J. Finch. The article offers two tables worked out to shorten the labor necessary for finding the efficiency of a seam.

Table 1 shows what the author calls "value of rivet holes in plates;" in other words, the strength removed from the plate for various sizes of holes and thicknesses of plate. Table 2 gives the shearing value of iron and steel rivets for the different sizes of rivets shown in Table 1. Examples are given showing the rapidity with which the efficiency of seams can be calculated by the use of these tables.

As regards the design of seams, the author compares a decuple seam with a diamond seam. The latter under certain conditions and properly designed can have a theoretical efficiency as high as 98 per cent, but the author points out that there are certain drawbacks to a seam of too high an efficiency as well as to a seam requiring a wide side welt like the diamond seam. Among these drawbacks is the difficulty to properly design the brackets to hold locomotive accessories and still retain a proper efficiency for the studs attaching these brackets to the boiler shell. (*Railway Mechanical Engineer*, vol. 96, no. 4, Apr., 1922, pp. 193–196, 5 figs., *p.A*)

WASTE PREVENTION

Utilization of Exhaust Steam from Electric Generating Stations, C. Ingham Haden. Discussion of prevention of waste of exhaust heat. The attitude which the author takes is that while the problem of lessening the waste of exhaust heat is a complex one, it is not impossible of solution.

The first main difficulty is to find a market for the heat; and if this is obtained the further difficulty arises of coördinating the loads, and from the point of view of economy he considers the heat load as a deciding factor.

Passing to the subject of super stations the author claims that the usual system of locating big generating stations at a supply of water for condensers is incorrect and it is the possibility of usefully employing exhaust heat that ought to be first considered in selecting their location. He further proposes the conversion of some of the existing generating stations which would be shut down under the superpower scheme but which are conveniently situated, into heat-distribution stations generating electric current as a by-product, and the linking up of such stations with the super stations.

While the superpower scheme considers generating stations from a comprehensive or national basis, it is equally important to consider the supply of heat upon a large scale. In practically all manufacturing localities there are industries that require heat in some form for boiling or drying purposes apart from the heating of the factories. Special arrangements would have to be made in such instances from a central source to supply steam at a suitable pressure, and this service could be maintained by live steam for continuous processes when the power plant was not running.

Utilization of exhaust steam for heat purposes, even at a pressure of 2 lb. per sq. in., would considerably reduce the electrical output and also render useless expensive condensing plants expressly designed to increase this output. The question resolves itself into one of economics, namely, would such a scheme be practicable and a paying proposition? The paper gives some practice of a typical district showing the probable heating and lighting loads, and finally describes installations which have already been carried out in England.

In the discussion which followed several references were made to American practice of district heating.

As an example of the author's method of calculation, the following may be cited. To take one example in London: a careful survey of the district within an approximate radius of half a mile from the generating station shows a possible heat load of 160,000 lb. of steam per hour, dealing only with buildings provided with existing installations for heating and hot-water supply, and those of suitable size for the steam service. If a further proportion of new buildings were erected within this area, this load could easily be doubled.

Taking the above figure as the demand, this would require additional steam at the station to allow for radiation losses, thus making the figure, say, 165,000 lb. of steam. With a boiler pressure of 150 lb. and superheat of 100 deg. fahr., and with generating plant designed for a back pressure of 60 lb. per sq. in. the steam consumption would be at the rate of about 115 lb. per kilowatt-hour, so that it would be possible to obtain power at the rate of about 1450 kw. Exhausting at 60 lb. per sq. in. there would still be some superheat in the steam, which would assist in reducing the radiation losses in the mains. The consumer would also benefit by any superheat remaining in the steam delivered to the calorifiers.

The net integrated load for the same district and buildings, allowing for average winter and summer conditions, amounts to 452,000,000 lb. of steam per annum. The gross income derived therefrom would amount to £90,400 if charged at the rate of 4 s. per 1000 lb., and the approximate number of electrical units obtained from the heat load to 3,930,000, which, at an average price of 2 s. 2 d. per unit, would amount to about £36,000.

The cost of the distributing mains, including all necessary work in the station and the formation of ducts, would depend upon the length of main required to serve the particular district, and the earning capacity of any main laid down would vary in like manner. Taking the same district, the total expenditure for engineers' work would be about £82,400, covering over 4 miles of streets, an average cost of £17,800 per mile, and an average earning capacity of £19,500 per mile.

The total load per mile is low, as one particular main a little over half a mile in length has an earning capacity of £23,800, equal to £37,000 per mile, showing that in districts where large buildings line the streets the income per mile would be still larger.

In addition to the distribution of heat by steam mains, it is possible in some cases to use hot water with advantage. (*The Journal of the Institution of Electrical Engineers*, vol. 60, no. 307, Mar., 1922, original paper pp. 265–271, discussion pp. 271–286, illustr., *pq.A*)

WELDING (See also Railroad Engineering)

The Dependability of Cast-Iron Welding, G. O. Carter. In welding cast iron preheating and annealing are essential, and before welding the complete casting must be brought to a red temperature. This makes the welder's job strenuous; nevertheless, good men can be secured to do the work.

The article cites facts to show that good results can be and are being obtained with cast-iron welding, especially where this work has been properly systematized. The subject of preheating of castings is briefly discussed in a practical manner.

In the opinion of the author the difference between perfect success in some instances of cast-iron welding and failure in others lies in the various degrees of preparation for welding and treatment subsequent to welding. Cast iron not prepared by adequate preheating is apt to crack, and the crack does not always take place at the weld. For best results, the entire casting should be at a red temperature, though there are cases where partial preheating is sufficient. (Paper read before the Cleveland Section of the American Welding Society, abstracted through *The Iron Age*, vol. 109, no. 14, Apr. 6, 1922, pp. 928–930, 8 figs., *p*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a resume of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Bearings A1-22. Friction and Carrying Capacity of Ball and Roller Bearings. The experiments which are recorded in this Technologic Paper No. 201 were carried on at the Bureau of Standards by H. L. Whittemore, mechanical engineer, and S. N. Petrenko, assistant mechanical engineer. Their purpose was to determine the maximum safe load and the static friction under load of ball and flexible roller bearings.

Tests were made on balls of 1.00, 1.25 and 1.50 inches diameter in grooved races and on rollers 1.25 inches in diameter and 5.25 inches long in flat and cylindrical races.

The total deformation and area of contact of bearings and races were measured and compared with Hertz's theory.

Conclusions: 1 The results agree roughly with Hertz's theory. The differences are ascribable to inhomogeneity of the material.

2 The ratio of friction to load is practically constant and equal to 0.00055 for all three sizes of balls up to a "critical" load, which varies with the diameter of ball: 1300 pounds for 1.00-inch, 1700 pounds for 1.25-inch, and 2200 pounds for 1.5-inch balls.

3 A similar "critical" load, 25,000 pounds, was found for the roller bearings with a ratio of friction to load equal to 0.00075.

4 This "critical" load at which the friction began to increase more rapidly was in all cases lower than the safe load as determined by permanent deformation and as calculated from Stribeck's law.

The complete paper may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 10 cents.

Cables and Ropes A1-22. Test of Manila Rope. The results of some tests of manila rope which had been conducted at the Bureau of Standards by Ambrose H. Stang and Lory R. Strickenberg are reported in Technologic Paper, No. 198. This paper summarizes the results of tensile tests of 368 specimens of manila rope. Most of the material was submitted on purchase orders for Government departments. They were all 3-strand, regular lay manila rope having diameters from 1/2 in. to 4 1/2 in.

A summary of the results is given in tables and graphically. A formula is given for determining the average breaking load as a function of the diameter of the rope. The test results cover sufficient range and show such consistency that it is believed that the formulas may be used safely for 3-strand, regular lay manila rope of the sizes indicated. The ropes showed a continually varying modulus of elasticity and no well-defined proportional limit. This paper may be obtained by addressing the Superintendent of Documents, Government Printing Office, Washington, D. C. Price per copy 5 cents.

Electrical Communication A2-22. High-Frequency Resistance of Induction Coils. See *Electricity, General A1-22.*

Electricity, General A1-22. High-Frequency Resistance of Induction Coils. On account of the importance of inductance coils in radio communication, careful studies, both theoretical and experimental, have been made at the Bureau of Standards on capacity effects and other effects in inductance coils at radio frequencies. Some of the results of these investigations are contained in a new publication, Bureau of Standards Scientific Paper No. 430, The High-Frequency Resistance of Inductance Coils. In this paper a formula for the resistance of an inductance coil is derived which takes into consideration both the skin effect and the capacity effect for the case of a short single-layer solenoid, and the results of experiments are given which check this formula. Other more general formulas for current distribution and resistance are also derived.

A copy of this paper may be purchased for 5 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Foundry Equipment, Materials and Methods A1-22. Molding Sand Reclamation. The Committee on Molding Sand Research through the courtesy of the American Steel Foundries Company has prepared a digest of the sand reclamation work carried on by the engineering staff of the A.S.F.

Because of the scarcity of steel-molding sand of the best quality and the problems arising from having to dispose of large quantities of refuse sand, this company has carried out an extensive investigation of methods of reclaiming the good material which is usually lost whenever the so-called refuse sand is thrown away. After experimenting along different lines and thoroughly going over methods employed in other plants, a process of reclaiming old sand called "centrifugal scrubbing" was developed.

The report covers the theory of sand reclaiming, centrifugal air-scrubbing process, cost of reclaiming sand by the latter process, and a description of the proposed sand-reclaiming unit. Address Alfred D. Flinn, Chairman of Division of Engineering, National Research Council, 29 West 39th Street, New York.

Fuel, Gas, Tar and Coke A8-22. Coal and Coke Mixtures as Water-Gas Generator Fuel. The scarcity of high-grade coke and the great rise in price of all grades of coke have made it almost necessary for some gas companies to consider the substitution of bituminous coal for coke as generator fuel, even though grave difficulties were expected in maintaining the capacity of the plant with the new fuel.

The experiments conducted at Streator, Ill., in 1918, in operating a 6-ft. set 6 to 7 hours a day did not solve some of the important questions in the use of coal fuel, namely, the effect of a stand-over period on capacity and possibilities in the use of the blow-run method of operating with mixed fuels, coal and coke. The chief purpose of this paper, therefore, is to present information bearing on these problems and the results obtained during six weeks of experiment at Davenport, Iowa, using mixed generator fuel with the blow-run method of operating. Data are included on the behavior of the various fuels used in the generator, the clinker conditions, the use of fuel high in ash, and on the use of coal high in sulphur.

This pamphlet which consists of 32 pages and is fully illustrated was prepared by W. W. Odell and is known as Bureau of Mines' Technical Paper 284. It was, however, prepared under a coöperative agreement with the Illinois State Geological Survey and the Engineering Experiment Station of the University of Illinois through its department of Mining Engineering. Address Superintendent of Documents, Government Printing Office, Washington, D. C. Price per copy 10 cents.

Glue A1-22. Copper Salts Improve Casein Glue. It has been found that copper salts added to casein glues greatly increase their resistance to moisture and also make them more durable when exposed to the action of molds and fungi. Casein glues containing copper are nearly as moisture-resistant as blood albumin glues.

In the preparation of copper-casein glue at the Forest Products Laboratory, 2 to 3 parts by weight of copper chloride or copper sulphate are dissolved in about 30 parts of water and are added to every 500 parts of the ordinary casein, lime and water-glass glue. The copper solution is poured into the glue in a thin stream. The violet-colored lumps formed at first by the coagulation of the glue by the copper solution are reduced by stirring vigorously for about 15 minutes, and a smooth violet-colored glue results. It is necessary to add the copper salts after the other ingredients are thoroughly mixed, in order to obtain beneficial results. Copper added to the casein before the lime and water glass is ineffective.

Glues containing little lime are especially improved by the addition of copper. A low-lime glue with copper may be as resistant to moisture as a glue with more lime in it, and copper does not shorten the "life" or period of workability of the glue so much as more lime would. Address the Forest Products Laboratory, U. S. Forest Service, Madison, Wisconsin.

Iron and Steel A1-22. Thermal Stresses in Chilled-Iron Car Wheels. See *Railroad Rolling Stock and Accessories A1-22.*

Petroleum, Asphalt and Wood Products A4-22. Specifications for Petroleum Products. A set of specifications for petroleum products have been officially adopted by the Federal Specification Board for the use of the various departments and independent establishments of the Government. They contain specifications for (*a*) various grades of gasoline, (*b*) naphthas, (*c*) burning oils, (*d*) fuel oils, (*e*) lubricants of all kinds. These specifications are printed in full as Technologic Paper No. 305 of the Bureau of Mines. Address H. Foster Bain, Director, Bureau of Mines, Washington, D. C.

Railroad Rolling Stock and Accessories A1-22. Thermal Stresses in Chilled-Iron Car Wheels. For over half a century most of the freight cars in this country have been equipped with chilled-iron car wheels. These wheels have given general satisfaction, even under the present existing conditions of greater speeds and increased stresses due to the use of heavier wheel loads. It has been observed, however, that failure of chilled-iron wheels occur occasionally at the foot of long, steep grades, and the greatest cause of such failures appears to be the heating of the tread by the prolonged application of the brake shoe.

A method was developed at the Bureau of Standards for testing car wheels in the laboratory under conditions approximating severe service. The wheels were heated by passing an electric current through a band of iron encircling the wheel; the resulting stresses were calculated from

strain-gage measurements after correcting for thermal expansion.

Twenty-eight wheels of varying weights and design from three manufacturers were tested in this manner, of which sixteen failed by cracking in the plate. Although the total number of wheels tested is too small to draw any definite conclusions, the results seem to point to the following generalities which should be confirmed by a greater number of tests:

1 The maximum stresses developed are very close to the tensile strength of the cast iron and are some function of the strength of the iron.

2 The maximum tensile stresses occur in a radial direction near the junction of the double plates in the M.C.B. or Washburn type of wheel. In the arch-plate type the maximum stress is somewhat nearer the hub. This seems a desirable condition in that it lies in the region where it is counteracted by the strains due to forcing the wheel on to its axle.

3 The stress in a tangential direction on the outer face and also the stress in both the radial and tangential directions on the bracket side of the wheel are relatively small when compared to those in a radial direction on the outer face of the wheel.

4 By proper distribution of metal in the single-plate type of wheel there would appear to be a possibility of securing a wheel more capable of meeting service requirements.

5 With identical rates of heat input the heavier-weight wheels withstand the effect of tread heating with less strain than the lighter wheels.

6 The tests also lead one to believe that the operating conditions to which wheels are subjected may be as important a factor in the safety of the wheel as are the problems arising in their manufacture.

G. K. Burgess and R. W. Woodward conducted these experiments and have described them in Technologic Paper No. 209. Address Superintendent of Documents, Government Printing Office, Washington, D. C. Price 5 cents.

Ropes and Cables A1-22. TEST OF MANILA ROPE. See *Cables and Ropes A1-22.*

Sound A1-22. SOUNDPROOF PARTITIONS. The results of an investigation of the acoustic properties of various building materials with their practical applications by Prof. F. R. Watson have recently been published as Bulletin No. 127 of the University of Illinois, Engineering Experiment Station, Urbana, Ill. The purpose of this investigation was to meet the demand for quiet rooms in hospitals, hotels, and office buildings and the desirability of insulating music studios and other rooms where disturbing sounds are produced; the necessity for solving other problems for the control of noise has led to repeated requests from architects and builders for reliable information on effective methods for insulating sound. Although present knowledge of the subject is incomplete, nevertheless, on account of the pressing need for guidance in such matters, it is thought desirable to collect and present the available information in a systematic way, giving the methods and results of various investigations relating to the action of materials on sound describing practical installations of soundproofing, and setting forth in accordance with existing knowledge recommendations that may be applied where sound insulation is wanted.

Wood Products A1-22. RED HICKORY AS STRONG AS WHITE HICKORY. The insistence of the public on having only white hickory in tool handles and vehicle parts causes a large part of the hickory grown in this country to be used for fuel or for other purposes where the exceptional strength properties of this wood are not needed. Usually only a small outer portion of a mature hickory tree contains white wood; the inner part, or heartwood, is red. Many people think that this red wood is not so strong or tough as the white wood. This belief, however, is discredited by actual strength tests made at the Forest Products Laboratory upon many specimens of red and white hickory. The tests show conclusively that, weight for weight, sound hickory has the same strength, toughness, and resistance to shock, regardless of whether it is red, white, or mixed red and white. Address the Forest Products Laboratory, U. S. Forest Service, Madison, Wisconsin.

Wood Products A2-22. WHEN PRESERVATIVE TREATMENT OF WOOD IS AN ECONOMY. Although any set of timbers may be made more resistant to decay by preservative treatment, such treatment may not always be economical, even though the timbers are to be exposed to the most severe fungus attack. If the timbers are to be in service for a short time only, durability is unimportant, and any kind of preservative treatment would obviously be a waste of money. If, on the other hand, the wood is naturally of low durability and is to be used in a permanent location, it is easy for preservative treatment to show great savings. Between these two extremes there are any number of instances in which it is a more difficult problem to determine whether or not preservative treatment will pay.

If a timber user knows the average life that treated and untreated timbers are giving and the cost of each in place, he can easily compute, with the use of a table recently published by the Forest Products Laboratory, the relative annual cost of maintaining the two.

If untreated timber is giving long life, treatment might not result in great savings. However, very often it might be possible to substitute for such timber a treated lower-grade material that would give as long or longer life with an annual maintenance charge which would compare very favorably with that of the better-grade, untreated timber. Address the Forest Products Laboratory, U. S. Forest Service, Madison, Wisconsin.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for cooperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged upon research problems. The addresses of these investigators are given for the purpose of correspondence.

Corrosion B2-22. CORROSION OF CHROMIUM STEELS. See *Steel, Its Treatment and Products B3-22.*

Foundry Equipment, Materials and Methods B3-22. MOLDING SAND. The Committee on Molding Sand Research, the organization of which was reported in the Engineering Research section of the February issue of MECHANICAL ENGINEERING, is making good progress. A Sub-Committee under the chairmanship of Prof. H. Ries, of Cornell University, is undertaking through the coöperation of the U. S. Geological Survey and the various state geological surveys a comprehensive survey of the molding-sand resources of the country.

The work on the standardization of tests is well under way. Questionnaires have been sent out to gather information on the present methods of testing the physical properties of molding sand and a digest of the replies to these questionnaires is expected to be available shortly.

Many firms and universities have offered to coöperate in the research work. Every endeavor will be made to maintain their interest and to assign problems to those universities and industrial laboratories offering to coöperate; due regard being given to the facilities and talent available. A list of research subjects has been compiled, which is given in part below.

1 Recovery of used molding sand through restoring bond to the sand by subjecting it to contact with water vapor under high pressure
2 The effects of additions of certain chemical reagents upon the physical properties of clays and clayey materials, such as molding sand
3 Effects of water content on the bond and permeability of a molding sand
4 Effects of different water per cents in molding sand and on the milling and drilling speeds of light gray-iron castings
5 Research on fusion quality of facings (Function of "peeler")
6 Tests of various kinds of clays for restoring bond to molding sand
7 Comparison of lives of different molding sands
8 Effects on plasticity of bond in molding sand and reduction of water content when using oil
9 Effects of wet and dry storing of sand on bonding quality.

Fuels, Gas, Tar and Coke B1-22. WATER-GAS TAR EMULSIONS. In Reports of Investigations, No. 2331, William W. Odell, gas engineer of the Bureau of Mines, outlines the essential facts so far brought out in an investigation into the causes for emulsion difficulties as experienced at many water-gas plants. The investigation was conducted under a coöperative agreement between the University of Illinois Engineering Experiment Station, the Illinois State Geological Survey, and the U. S. Bureau of Mines. Funds of the Illinois Gas Association were used to defray a part of the costs.

Active assistance was rendered by the Peoples' Gas Light and Coke Co. of Chicago, who furnished a laboratory at Chicago for conducting the experiments, and loaned the services of E. A. Thiele to help with the laboratory work.

A full report on the results of this work will be published by the Bureau of Mines later, but it is believed desirable to bring the principal results now to the attention of the industry.

This report discusses the subject under the following heads, (*a*) Water-Gas Tar—What it really is, (*b*) Water-Gas Tar Emulsions and Their Formation, (*c*) Quality of Water-Gas Tar, (*d*) Factors Affecting the Settling of and Formation of Tar Emulsions, (*e*) Summary and Conclusions.

Copies of this report may be obtained by addressing H. Foster Bain, Director, Bureau of Mines, Washington, D. C.

Heat Transmission B2-22. HEAT TRANSMISSION THROUGH ENGINEERING MATERIALS. The Annual Report of the Engineering Division of the National Research Council contains a statement concerning the effort which is being made to organize a committee for the purpose of investigating the problems of heat transmission. These problems are important and fundamental to many industries. At the present time, however, there is no exact information on the heat conductivity of many materials. This is due largely to a lack of standardization of apparatus and methods which has resulted in a wide divergence of experimental results. Several societies now have committees organized for investigations of this kind and numerous investigators are at work in the university, industrial and governmental laboratories. The Division of Engineering with the coöperation of the Division of Physical Sciences plans that the new committee will coördinate all the present activities into a comprehensive program. Address Alfred D. Flinn, Chairman of Division of Engineering, National Research Council, 29 West 39th Street, New York.

Magnetism B1-22. MAGNETIC MEASUREMENTS ON SMALL SAMPLES OF MATERIALS. The standard methods of making magnetic measurements which are now in use require relatively large samples of material. While these methods are fairly satisfactory for most purposes, many

cases occur where it would be desirable to make reliable measurements on smaller samples. For example, in researches on the properties of different materials and in the development of materials for particular purposes, the expense would be very greatly reduced if small samples could be made to serve. In order to meet this need, a special study has been made at the Bureau of Standards, and apparatus has been constructed which requires a sample only 10 cm. long and 6 mm. in diameter. This work is not yet complete, but the data already obtained indicate that the apparatus will give very satisfactory results.

Steel, Its Treatment and Products B4-22. CORROSION OF CHROMIUM STEELS. It appears from a series of tests on the corrosion of chromium steel that the behavior of the material when subjected to the acid test is not a sure criterion of its resistance to atmospheric corrosion. Of all the alloys examined, a high nickel-chromium steel, invar, pure iron, and medium-carbon steel (very slowly cooled from a high temperature) were the most resistant to hydrochloric acid as measured by the loss of weight per unit area per day. High-chromium steels (for example, 13.70 per cent Cr, 0.29 per cent C) were found to be attacked by acid very much more readily. However, when the same specimens were subjected to a weathering test, consisting of a partial immersion in water and exposure to the air, the order of resistance was almost completely reversed. The high-chromium steels were the ones to withstand the treatment best, the low-chromium ones and the pure iron showing rust spots early in the test. The combination of both nickel and chromium appears to make the steel resistant to both acid and weather attack. In general, the steels which were quenched were found to resist corrosion better than the same material in the annealed state, but the differences found were much less than the differences resulting from composition changes, thus indicating that composition rather than treatment should receive primary consideration. Address Dr. S. W. Stratton, Department of Commerce, Bureau of Standards, Washington, D. C.

Steel, Its Treatment and Products B3-22. CUTTING TESTS OF HIGH-SPEED-STEEL TOOL BITS. The Bureau of Standards has completed during the past month about 60 more tests on ½-in. tool bits made of several grades of high-speed steel which had been subjected to various heat treatments. A preliminary summary of a portion of these tests for one steel containing 0.62 per cent carbon, 3.5 per cent chromium, 15.5 per cent tungsten, and 1.6 per cent vanadium was made. An interesting feature of these tests is the effect of the temperature of preheating on the cutting qualities of the tools as expressed in pounds of metal cut away. This is shown in the following table:

Preheating (Time for cut, 20 minutes)	Hardening (Time for cut, 5 minutes)	Lb. of metal cut per tool (4 tools tested)
1400 deg. fahr.	2417 deg. fahr.—oil	9.1
1500 deg. fahr.	2417 deg. fahr.—oil	10.1
1600 deg. fahr.	2417 deg. fahr.—oil	5.1
1600 deg. fahr.	2417 deg. fahr.—water	5.1

(All testing conditions were the same)

The results obtained when using water as the quenching medium are about the same as when using oil for this particular purpose.

D—RESEARCH EQUIPMENT

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories.

Forest Products D1-22. THE FOREST PRODUCTS LABORATORY, MADISON, WIS. The Decennial Celebration of the founding of the Forest Products Laboratory at Madison, Wisconsin, is the immediate reason for the publication of a handsomely printed booklet, descriptive of the history and work of this well-known laboratory. This book, which is fully illustrated, contains 196 pages and has chapters on the following subjects, (*a*) Wood and Human Progress, (*b*) Early Perspectives of Forest Utilization, (*c*) The Forest Products Laboratory, (*d*) Ten Years of Research in Forest Products, (*e*) Financial Value of Research Results, (*f*) Future Research in Forest Products, (*g*) How to Use the Laboratory.

F—BIBLIOGRAPHIES

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the office of the Society.

Fuels, Gas, Tar and Coke, F1-22. BIBLIOGRAPHY OF LITERATURE ON SAMPLING. So far as known there is no complete bibliography on sampling so one recently compiled by W. J. Sharwood and M. W. von Bernewitz should be of value. It contains nearly eleven hundred references, some dating back 30 years, on sampling at mines, mills, smelters, power plants, pumping stations and refineries. For convenience, it includes a few references to methods for sampling such materials as leather belting in mills, salt-impregnated soils, and mine waters. All the important technical journals, including some of those published in foreign countries, and mining and metallurgical textbooks, have been studied for anything concerning sampling. The arrangement is alphabetical by authors' names, and the items are numbered serially. A copy of this bibliography can be obtained on application to H. Foster Bain, Director, Bureau of Mines, Washington, D. C. It is known as U. S. Bureau of Mines, Reports of Investigations No. 2336.

Machine Design F1-22. OIL FILMS IN BEARING. A bibliography of 3½ pages. Search 3471.

WORK OF THE A.S.M.E. BOILER CODE COMMITTEE

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in MECHANICAL ENGINEERING.

Below are given the interpretations of the Committee in Cases Nos. 391 to 394 inclusive, as formulated at the meeting of April 6, 1922, and approved by the Council. In accordance with the Committee's practice, the names of inquirers have been omitted.

CASE NO. 391

(In the hands of the Committee)

CASE NO. 392

Inquiry: If the holes in a plate are drilled full size in the plate before the sheet is rolled and holes in butt straps are also drilled full size before being attached by tack bolts to the plate, would this meet the requirements of Pars. 253 and 254 of the Code?

Reply: The intent of the requirement in Par. 253, that the plates shall be firmly bolted in position for drilling, is to make the holes match perfectly and it is the opinion of the Committee that this can be accomplished only by reaming or drilling the plates after rolling and with the butt straps in position.

CASE NO. 393

Inquiry: Should the factor "E," in Par. L-43*b* of the Locomotive Boiler Code, be calculated in a longitudinal direction, or transversely, as is "s?"

Reply: "E" refers to the minimum efficiency of the wrapper sheet through joints or stayholes located on a longitudinal section, as explained by the paragraph immediately following the formula.

CASE NO. 394

Inquiry: Is it permissible to stamp A.S.M.E. Standard on a low-pressure heating boiler which has autogenously welded joints and stays but complies with all requirements of the present Code?

Reply: At the time the heating boiler code was adopted, the use of autogenous welding in the construction of boilers for this service was not contemplated, and no permission for their use is contained in the Code. However, it is the opinion of the Committee that properly designed and constructed welded steel-plate boilers built of material in accordance with the specifications in the heating boiler section of this Code, when constructed, tested and operated in accordance with the rules in that section may safely be used and may be stamped A.S.M.E. Standard, for a working pressure not to exceed 15 lb. per sq. in. steam pressure, or 50 lb. per sq. in. hot-water pressure. The decision whether such boilers may be used thus necessarily rests with the authorities having jurisdiction.

Part I, Section 2 of the Code is now being revised and this interpretation is subject to the rules for welding of heating boilers which will be incorporated therein.

MECHANICAL ENGINEERING

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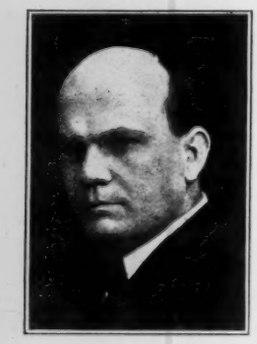
C 55 The Society as a body is not responsible for the statements of facts or opinions advanced in papers or discussions.

Intermittent Operation of American Industry

THERE are two forms of intermittent operation in American industry: First, that which obtains every seven to ten years and is commonly referred to as the Business Cycle or Cyclical Depression; second, that form usually referred to as Intermittent Employment or Seasonal Operation.



L. W. WALLACE

The wonder is that these forms of business depressions have not been given the consideration and constructive thought that their magnitude and their seriousness demand.

The ill effects of the cyclical depression are immeasurable. It is known in a general way that through the workings of the business cycle millions of men and women are forced out of employment for months at a time, yet at no time or place has there been accumulated authoritative information as to the primary causes of such depressions. There is no source that one can turn to for helpful suggestions as to what measures may be invoked to forestall the evil day or to mitigate its destructive influences once it has arrived.

Federal and state legislative bodies, fond though they appear to be of passing legislation pertaining to business, have not evolved any constructive legislation bearing upon this serious economic and social phenomenon.

Senator Kenyon, in the last days of his service in the U. S. Senate, did introduce a bill which contained a fundamental conception of the problem and which did at least suggest a means of preparing for cyclical depression. The preamble to this bill stated:

> Whereas a sound economic policy requires that a larger percentage of the public works and projects of the United States be undertaken and prosecuted during a period of major industrial depression and unemployment, when labor and capital are not fully employed in private industry, that a smaller percentage of such works and projects should be undertaken and prosecuted during a period when industry is active and competing for the same men and material with resulting business strain and overextension, and that the prosecution of such works and projects should be utilized as a stabilizing force during a period of overexpansion as well as during a period of depression, it is the purpose of this Act to grant the authority necessary to carry out this policy.

This bill met with such opposition that Senator Kenyon moved that it be referred back to the committee. This was done and thus one earnest effort to undertake some solution of the problem was disposed of. Future efforts, it is hoped, will be more successful.

The Permanent Committee of the President's Conference on Unemployment has recognized the problem as one of great importance and seriousness. It has therefore secured sufficient funds to finance a comprehensive study of the business cycle. This study is now being conducted by Dr. Wesley Mitchell and associates, assisted by a number of organizations.

The Federated American Engineering Societies is conducting one phase of the study. It is being assisted by over one hundred and twenty different groups of engineers. This is the first comprehensive study of business cycles ever undertaken. The results to be disclosed, when the work is completed, promise to be of very great importance. It is expected that from this study there will come such concerted action as to greatly reduce the ill effects of cyclical depressions in the future.

It is the belief of some, which belief is based upon a large amount of data, that the economic, civic and social losses due to seasonal operation are even greater than those due to business depression such as is now being experienced. This phase of American industry has not challenged the thought of those concerned as its seriousness demands. For instance, but few have known or realized that—

(1) In 1919, the employees in the paper box, women's clothing, confectionery, overalls, brick, chemical and glass industries lost from 10 to 15 per cent of the possible working days

(2) Bituminous coal mines have operated on an average of only 214 days per year since 1890, the loss in time being an average of 90 days per year

(3) The annual loss in the shoe industry due to seasonal operation is approximately $65,000,000

(4) In the clothing industry there is an extensive unemployment period twice a year which averages 31 per cent of the possible working days and affects from 80 to 90 per cent of the workers

(5) The worker in the construction industry works on the average of only 190 days in the year, that is, he is idle 33 per cent of the time. Many other examples might be cited.

It is a safe assumption that in most of the industries the plant equipment and the materials in stock are idle the same percentage of the time that labor is. All of this contributes a large amount of the unearned overhead account.

In this connection it is of importance to note that it is in the most highly seasonal industries where bitter and costly labor difficulties occur the most frequently. In 1919 in New York state 32 per cent of all the strikes were in the construction and clothing industries, the two that operate largely upon a seasonal basis.

It is recognized that it is a difficult task for some industries to avoid seasonal aspects. But it is also known that some industries that were once considered unalterably seasonal in character now operate on a uniform schedule throughout the year. These industries carefully analyzed the problem, thereby disclosing the changes necessary to be made in practices and policies in order to eliminate the evil. When these necessary changes were adopted, a greatly improved condition obtained.

This aspect of American industry requires careful study upon the part of some authoritative, competent and unbiased group. It would be of great assistance for all concerned to have full information as to what each individual plan has done to reduce the seasonal aspect of its operation. This information would stimulate others to make a similar effort.

The elimination of the losses due to cyclical depressions and to seasonal operation of American industry will require earnest, continued and persistent effort. They are not common to one plant or industry, hence the manager of no one plant or industry can adequately deal with them. They can be adequately dealt with only through collective action.

The best means of accomplishing the necessary collective action is through the coöperation of trade associations and engineering societies. These problems should challenge the efforts of such organizations, because in their solution lies a very large economic and social advancement of the body politic. L. W. WALLACE.[1]

[1] Executive Secretary to the American Engineering Council.

The Growing Importance of Safety Codes

THE engineering profession has always been one of the leaders in the development of anything of service to the human race, ready to further every sensible means or method which has for its object the safeguarding of the worker against the hazards of his occupation or the safeguarding of the public against the risks that it must take in connection with the use of public or private conveyances.

JOHN W. UPP

The engineer cannot condone the lack of safeguards which, if used, would eliminate unnecessary risks and reduce the number of injuries. For the workman will do more and better work if he is relieved of the nervous strain which he must continually undergo when he knows that, as in the case of unguarded machines, the slightest slip or inattention may result in temporary or permanent injury.

The number of preventable accidents which are constantly taking place is of real concern to the designing engineer and is an incentive for him to improve the operating efficiency of the inanimate machine as well as to secure the efficiency of human endeavor by reducing to its lowest point the harmful results that come from the operation of such a machine improperly safeguarded. He desires to increase efficiency in operation, but the loss of hands, legs, eyes or earning capacity is to him more objectionable than loss in horsepower.

The engineer has often acted individually to introduce safeguards which could be successfully financed through the coördination of the adverse interests involved. But progress has been slow because the individual as well as the corporation has a well-understood tendency to follow the old and accustomed standards unless some concerted action is taken to get them out of the beaten path. Because of established practice it often takes a long time before satisfactory results can be accomplished.

We have reached the point, however, where the efforts of the engineer to introduce his own ideas and measures for safety in the individual installation can now be combined with the efforts of practically the entire fraternity working along similar lines. We can codify for general use the knowledge of the group, and with the backing of a Society such as ours and the help of other interested bodies of national standing, we can disseminate that knowledge for the guidance of all concerned in the operation of the machinery coming under the classification of a given code.

The code brings together for easy reference and use the combined practical experience of the recognized leaders in the profession. It greatly assists in the application of safety devices because it lists only the rules and regulations which have been put to the test and proved of value.

An adopted code is a definite help in the process of standardization because when the code is accepted the devices which meet the specifications are uniformly manufactured. This means that the design will be in the hands of the manufacturer—where it belongs, but the inefficient and troublesome practice of making changes in details of construction to satisfy the varied personal ideas of the many individuals authorized to give approvals in the different sections of the country will be eliminated.

A code decreases the cost of manufacture and the price to the user because of the reduction in the number of special devices, and it will improve the quality and the performance of the devices themselves. For when the manufacturer feels that his equipment will be passed as satisfactory if it meets the degree of safety called for in a uniform set of regulations, he will naturally spend more time and money in the development of devices or machines which he can sell in comparatively large quantities. More attention can be paid to economical design, important tool equipment can be introduced, and a more satisfactory article produced and at a lower cost.

The safety code grows in importance as its purpose and benefits become better understood, for from whatever angle the subject is approached, the conclusion must be reached that the code, properly prepared, is the best means so far developed for assisting in the application of safety devices and the reduction in the accident hazard.

We should not leave this subject without paying respect to the excellent work that engineers connected with the Society have done in the development of safeguards for use on moving machinery, but we may be pardoned for suggesting that there is much more to be done in this direction. We hope that every member of the Society will consider himself responsible in some measure for carrying on this useful work, and when a code has been sanctioned by the Society that each member will familiarize himself with its contents and give the weight of his good will to the rules and regulations on every suitable occasion.

JOHN W. UPP.[1]

Engineers Again Needed in Patent Legislation Situation

DURING the month of March there were introduced into the Senate two bills seeking to amend the patent laws, which, in the opinion of the writer, are exceedingly dangerous and which, if passed, would be destructive of the American patent system. These are Stanley Bill, S-3325, providing for the granting of compulsory licenses where patents have not been worked to a reasonable extent within a reasonable time, which amended Section 4887 of the Revised Statutes of the United States; which bill was replaced by Stanley Bill, S-3410, which applied the same amendment to Section 4886 of the Revised Statutes. The former Stanley Bill might, in effect, apply only to foreign-owned American patents, but the substitute bill would unquestionably apply to all United States patents, whether owned by American citizens or aliens. The questions of whether a patent had been worked to a reasonable extent and within a reasonable time, are to be decided by the Commissioner of Patents or such other governmental agency as the President shall designate. The Ladd Bill, S-3297, was also introduced, and this bill provides that patents shall lapse if not worked within five years after they are granted, or two years after they have been assigned. These bills would so lessen the value of patents that the incentive to produce inventions would be so greatly decreased as to put our American patent system in the position of a second- or third-class system and deprive our country of that incentive to invent which has made us the foremost country in inventiveness, in manufacturing, and in agriculture.

The object of the bills is to throw German-owned American patents open to American use and prevent the Germans from manufacturing in Germany and importing here, while restraining the use of their invention here through their American patents.

The International Convention, to which most of the leading countries are parties, would prevent a working clause in our law which applied only to aliens. Therefore, the Stanley and Ladd Bills apply to all American patents.

The path which an inventor must travel before he can reap any return is already so difficult that many doubt that it is worth while to make inventions. The cost of "working" a patent is sufficiently large, so that if it had to be done merely to keep the patent alive, and whether commercial conditions would justify it or not, it could not ordinarily be undertaken, and most patents would lapse for that reason.

Few individuals or corporations would buy patents with a working clause hanging over them. Those patents which only become valuable and profitable during the last two or three years of their life would almost always have lapsed before that period would have been reached, to the embitterment of their inventors or owners and to the discouragement of all who knew of the experience. Where, as is usually the case, a development requires a number of years and the production of a series of patents, either for successive improvements or for auxiliary inventions, the expense of working a number of patents would be incurred, and the earlier patents would often have to be worked before the development had reached a successful conclusion and hence without any knowledge that any working would ever be justified.

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[1] Manager, Switchboard Dept., Gen. Elec. Co., Schenectady, N. Y., and Chairman of the Standing Committee on Safety Codes.

Where it was necessary to patent several alternative inventions and no basic patent could be obtained to cover all the forms, each of the alternative forms would have to be worked to keep out competition. The expense of this possible multiple working would deter many manufacturers from entering at all upon a development. The working or compulsory license requirements would favor the rich inventor or corporation as against the poor inventor.

For these reasons, the market for patents would be largely decreased and hence the incentive to invent severely lessened to the defeat of the object of the patent system.

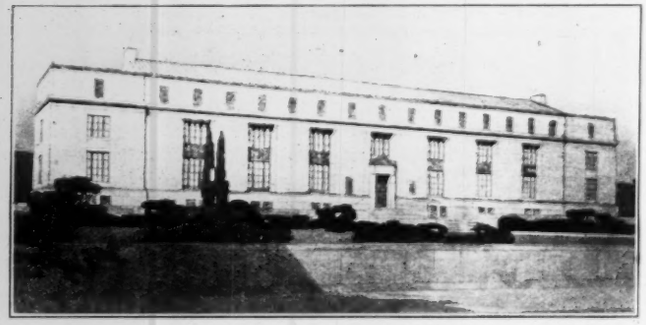
The Patents Committee of the American Engineering Council has been authorized to vigorously oppose the passage of the bills.

The Patents Committee of the Senate held a hearing on the Stanley Bill, S-3410, on April 6 and, because of protests at the shortness of the notice, the hearing was continued to May first and second. The Patents Committee of the Council arranged for a delegation to appear at the hearing, and a vigorous argument and protest against the passage of the bills were made.

EDWIN J. PRINDLE, *Chairman*,
Patents Committee, American Engineering Council.

National Academy of Sciences and National Research Council to Have New Building

Plans for the erection in Washington of a $1,300,000 building as the home of the National Academy of Sciences and the National Research Council and a center for American science in all its fields



ARTIST'S DRAWING OF THE NEW BUILDING FOR THE NATIONAL ACADEMY OF SCIENCES AND THE NATIONAL RESEARCH COUNCIL

have been announced by Dr. C. L. Walcott, President of the National Academy. The building, the completion of which is expected by a year from next fall, is the gift of the Carnegie Foundation of New York.

In addition to serving as a conference center for scientists, the institution will be designed as a "mutating museum" of the progress of scientific achievement. A large auditorium and a lecture room on the main floor will be surrounded by seven exhibition rooms, in which the newest scientific discoveries will be illustrated for the benefit of the public. One of the most interesting features of the building will be a coelostat telescope which will throw a large image of the sun on a white surface and demonstrate to the layman the natural phenomenon of sun spots.

Second Public Conference on Commercial Engineering

Engineers, business men, and educators from all parts of the country met at the public conference on Commercial Engineering held May 1 and 2 at Carnegie Institute of Technology, Pittsburgh. It was the second public forum on this subject, and was called by the U. S. Commissioner of Education on behalf of a national committee appointed to investigate business training of the engineering student, and engineering training of the business student.

The term "commercial engineering" is rather new; but the need for it is an old one. The primary cause of the investigations and the subsequent conferences was the realization among industrial executives that engineers were overtrained technically, and undertrained commercially. The necessity of a business training along with engineering development is felt by every engineering student soon after leaving college. To bring about a better coördination of college curricula as the means to make better business men of engineers, and conversely, better technically trained business students, was the basis of the conference discussions.

The convention provided the rare opportunity for industrial executives to tell educators where engineering students fell short as soon as they entered industrial life. Educator met educator and exchanged ideas on the best methods to coördinate business and engineering courses.

The first three sessions of the conference were group sessions where the following topics were discussed: Current practices in colleges and universities relating to business training for engineers and engineering training for business men; coördination of college training with the industrial demand; and civic and social training of the engineer and business man. The fourth session of the conference was a series of group conferences where the topics of the first three sessions were again the subjects of discussion and where the fourth group met to talk over the training of the engineer for management of overseas engineering projects.

Internationally known engineers, business men, and college executives spoke at the various sessions, and many prominent men took active part in discussing the various angles of the problem. Samuel Insull, President of the Commonwealth Edison Co., F. B. Jewett, Vice-President of the Western Electric Co., Eugene Meyer, Jr., Director of the War Finance Corporation, Dr. C. R. Mann, of the War Department, Dean Dexter S. Kimball, President of The American Society of Mechanical Engineers, and L. W. Wallace, Executive Secretary of the Federated American Engineering Societies were prominent speakers or group chairmen.

A Discussion of Draft-Tube Designs

TO THE EDITOR:

Referring to Mr. W. K. Ramsey's paper entitled A Discussion of Draft-Tube Designs, published on pages 171–176 of the March issue of MECHANICAL ENGINEERING, I beg to take exception to the author's views upon the cause of the phenomenon of water being drawn up in the central region of a draft tube at lower gates.

Mr. Ramsey ascribes this phenomenon to the action of a "great centrifugal force of water whirling down a draft tube." According to his description "this column ascends to a point directly beneath the runner where it turns over and down and is discharged down the tube." Further down on the same page (171) we read that "when the runner is discharging water at best gate, the water is flowing down in practically straight stream lines" and "under this condition there is no centrifugal action to cause the water to be drawn up from the tail race."

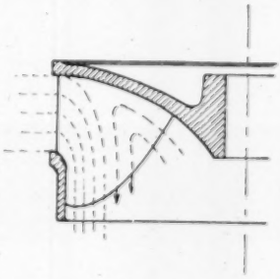


FIG. 1

I wish to remark that the phenomenon in question has been known for a long time and was long ago explained. Being due to the action of runner vanes, the inner parts of which run empty at lower gates, it has been named "pumping action." The ascending column of water goes further up than the point "directly beneath the runner;" it enters the runner, fills its empty space, and is discharged from it (see Fig. 1). This pumping action goes on at the expense of energy of a runner and is largely responsible for the decrease of efficiency of turbines at lower gates. It is to some extent controllable by suitable runner design. Of course there can be no pumping action in turbines at full gate, no matter what may be the direction of the velocity of discharge.

Those interested may find a full explanation of the matter in the works of R. Honold (Honold-Albrecht, Francis Turbinen, Mittweida 1907, pp. 56–57) and Professor Camerer (Vorlesungen über Wasserkraftmaschinen, Leipzig, Engelmann, 1914, p. 360).

WITOLD M. AULICH, M.E., Eng.D.
2533 Orchard St., Chicago Ill.

Engineering and Industrial Standardization

Machine-Tool Elements to be Standardized

As the result of a joint conference which was held in Atlantic City on April 26 it is more than probable that the standardization of certain machine-tool elements will be accomplished in the very near future. This joint conference between representatives of the National Machine Tool Builders' Association and The American Society of Mechanical Engineers was part of the regular program of the Association's Spring Meeting.

These two organizations, having sometime ago accepted joint sponsorship for a Sectional Committee which is to undertake this work under the Rules of the American Engineering Standards Committee, arranged for this conference to determine which of the machine-tool elements should be considered first. General Manager E. F. DuBrul who presided at the conference reported the results of an investigation which he has been making into the size, proportions and spacing of tee (T) slots as found on the various machines now on the market. This report opened up the subject completely and many of those present took part in the discussion. A few of the machine-tool parts and dimensions which in the opinion of the conference should receive the attention of the Sectional Committee are listed below under the heads of the machine tools to which they apply:

Lathe

1 Tee (T) slots
2 Standard rating (What is a 14 in. lathe?)
3 Nose piece
4 Bolt heads and nuts

Drills

1 Tee (T) slots
2 Spindle nose
3 Taper

Milling Machines

1 Tee (T) slots
2 Spindle ends
3 Angle blocks
4 Bolt heads and nuts

Planer

1 Tee (T) slots
2 Bolt heads and nuts
3 Distance between housing
4 Length of bed

Boring Mills

1 Tee (T) slots
2 Ram and turret tool holders
3 Diameter of hole in table
4 Bolt heads and nuts

It will be seen that the majority of these elements can be classed as tool or work-holding elements. This brings us to mention the key-note of the conference, namely, "the purchaser should have something to say." The Sectional Committee which is being organized to carry on this work will consist of representatives of the manufacturers (producers), users (consumers), and general interests (neither one nor the other). All those who are or have been in touch with a machine shop in which are installed various kinds of machine tools and various makers of the same tool need not be told of the great saving in cost of parts of jigs and fittings and in time due to interchangeability, which would result from the standardization of certain of the elements common to a number of machines.

At the close of the discussion it was agreed that a Plan and Scope Committee be first organized to make a careful survey of the field which is to be covered by the work of the Sectional Committee and to assist in determining its personnel. It was suggested that this Committee consist of five representatives of the N.M.T.B.A. and five representatives of the A.S.M.E. and it was further decided that the representatives of the N.M.T.B.A. should be drawn one each from the manufacturers of the following five types of machine tools:

(1) Planing
(2) Work revolving
(3) Tool revolving
(4) Grinding
(5) Punching and forming.

The dealers also are to be asked to coöperate by making suggestions for the use of the Committee and by assisting in the promulgation of the standards when they are developed.

Standardization—Its Fundamental Importance to Prosperity

This is the subject which Mr. Charles le Maistre, Secretary of the British Engineering Standards Association, chose for his address before the General Meeting of the North-East Coast Institution of Engineers and Shipbuilders held at Newcastle-upon-Tyne the last week of March. While speaking of the general principles underlying standardization, he said in part:

Standardization is not an easy term to define. There is nothing, however, new in the idea for it has been practiced in one form or another for many centuries, and starting from the moral and social side with standards of conduct, standards in art and in literature and so forth, has in later years gradually developed as an economic movement in the production of the material necessities of life, a departure of interest to everyone, seeing that it implies both the study and the preparation, as well as the recognition of standard forms and qualities. In its broadest aspect it may be said to imply the introduction, through collective effort, of economical methods of manufacture, not so much with the idea of gaining dividends as of unifying the needs of industry and thus bringing about the greatest amount of good for the greatest number. But it is not so much a definition of standardization that is wanted as an understanding of its underlying principles, and perhaps the best way of arriving at this is through actual experience in the working out in practice of the standards.

It is still sometimes urged against standardization that it retards invention and progress, and that once a standard has been adopted there is no possibility of modification or change even though new methods may have demonstrated their superiority over the old. Happily this is not the case so far as industrial standardization is concerned when carried on along right lines. Of course, crystallization which would tend to impede or hamper progress must be jealously guarded against so that the work may be of permanent value and the purchaser reap the benefit of competitive effort and inventive genius. Periodic review prevents crystallization and keeps the work abreast of progress. Nor is standardization coercion either by Government or by one section of the community over the other: indeed, there is nothing compulsory in it at all, its only authority being industrial public opinion.

Industrial standardization does not necessarily involve the idea of actual perfection; it is rather the registering of what is best in present practice as against attempting to set up an ideal. It is quite easy to set up a standard, but it is altogether another thing to get that standard widely adopted, and a standard which is not in accordance with the fundamental needs of industry, that is, which does not fulfill a recognized want, is economically a bad one. It is a wasted effort and a pitfall for the unwary.

In carrying out the work of industrial standardization, the aim should be to unify the requirements of industry to the best possible advantage without striving for an ideal which might involve an unnecessary sacrifice of capital. It is the buyer in the first instance to whom standardization is of the utmost value, for it enables him to know exactly what he can purchase and to be sure that he gets what he asks for in return for his money. But it is of equal value to the manufacturer for it simplifies his work, it enables him to produce what is required by the purchaser cheaply and expeditiously, as well as to avoid mistakes. It will thus be seen that the community of interest of the buyer and seller is one of the fundamental ideas underlying the work, for there cannot be the least doubt that the interests of both are really identical.

Every problem of standardization may be divided into the technical and the human side, and in most cases the human side is well over 85 per cent of the total. The technical factors are usually so well known that the problem so far as this is concerned becomes one of basic facts rather than of opinion, but when we come to deal with the human side so very little is known of the reasons actuating us all that we deal largely with so-called human opinion, which sometimes is not too closely related to the facts.

It must be remembered that standardization is really a science all of its own, and it is only gradually that its underlying principles have unfolded themselves and its great economic utility become recognized. Gradually, however, it has come to be seen and appreciated that standardization to be of lasting benefit must first of all be approached through the industrial side, the initial proposals coming from the manufacturers, the constructive criticism being supplied by the scientific and technical experts. That does not say that there are not isolated cases where the reverse is true, and rightly so.

The full realization of the economical side will always result in producing standard specifications which, though perhaps not ideal, yet represent the best which can be devised at the moment, improvements being effected through the process of time.

To be received with confidence by industry, standards must have a certain measure of permanency, and while crystallization must be avoided by periodical review as already mentioned, they must not be changed too often unless the changes are distinctly in the direction of improvements, ands afeguards must be created so as to protect those standards from change merely for the sake of change. Standardization, based on these principles, can never result in fossilization or stultification of invention and progress. Indeed, they invite improvement and progress.

Industrial standardization, then, has for its main objects the elimination

of waste of time and material involved in the production of a multiplicity of sizes and qualities for one and the same purpose, the fixing of the dimensions of component parts where interchangeability is necessary, the setting up of standards of performance whereby comparisons can be made with equity as well as the defining of attainable quality of material which involves unification of tests. Rapid and economical production may certainly be claimed as one of the leading benefits, and the securing of this is not only advantageous to the manufacturer but also to the consumer in the rapidity with which his orders can be filled from stock, the ready replacement of damaged and worn parts, and not infrequently the reduction in selling price. Notable examples of the increased business resulting from standardization can be seen in the well-known cases of the ordinary sewing machine and the bicycle. Interchangeability of component parts secured through standardization will give the purchaser the great advantage of an open market.

It should not be forgotten that the setting up of standards or the drafting of national purchasing specifications does not prevent a purchaser from obtaining anything which is not included in those specifications. He may possibly have to pay more for it and perhaps it is sometimes wise that he should. To be of the greatest benefit industrial standardization must be arrived at through the elimination of the unnecessary and the recognition that the recommendations are not unalterable, but rather subject to review, certainly not too frequently as I have already said, but whenever industry finds it economically desirable or necessary to do so.

The aim of those engaged in standardization must be to unify the needs and requirements of industry and that without hampering invention and design, and so encourage and direct progress along the best and most efficient lines.

Standardization, or unification as it might more appropriately be called, as signifying this great community of interest, goes so deep down and touches so closely on life's fundamentals, that to carry it out successfully requires much patience, caution, and evidences of vision, combined with optimism, good will and idealism. Fortunately these qualities are to be found increasingly among those who go to make up the great engineering industry of our country. All who are engaged in serving the public have a unity of purpose which is increasingly recognized, and as time moves on people are more and more willing to sink their individual differences with a view of benefiting the many.

When one considers the public-spirited manner in which so many freely give their valuable time and experience to this work, often at so much personal expense and inconvenience, one realizes indeed what a debt the nation owes to our engineers and business men for the part they are taking in this national work.

Florence M. Griswold Dies

Florence M. Griswold, who was often spoken of as the "Dean of Fire Insurance Engineers," and who was responsible for the standardization of fire-hose couplings, died on April 25, 1922. Mr. Griswold was born in Hoboken, New Jersey, in November, 1843, and received his education in the public schools there and at Wittenburg College, Springfield, Ohio. He served in the Union forces during the Civil War.

At the close of the war he entered the insurance business under the supervision of his father, Jeremiah Griswold, who was the author of many publications on various phases of the insurance business. Until 1875 he was connected with several of the principal fire-insurance companies in various responsible capacities, when he became general inspector of the Home Insurance Co. of New York. Since that time he had particular charge of the special hazards and technical work conducted by this company throughout the whole field of its operation.

When Mr. Griswold entered the insurance business the system was admitted to be one of guessing as to hazards and rates. He began to study the situation in an attempt to reach the scientific principles underlying it. He made himself familiar with the methods of all classes of manufacturing industries and the fire hazards incident to each. He assisted in the organization of many of the inspection bureaus and had an active hand in the formulation of a number of schedules for rating industrial plants.

His investigations naturally led him into the field of fire extinguishment. For many years he worked strenuously to secure universal standards for all classes of fire-fighting facilities and utilities. The National Fire Protection Association selected him to head a special committee to secure the adoption of a universal standard for hose and hydrant threads. Persistent efforts in this direction had failed many times in the past. Mr. Griswold was finally able to secure for his coupling the endorsement of many of the leading and most influential organizations of this country, and its use became general in all parts of the country. In 1917 it was approved and adopted by the United States Bureau of Standards as the "National Standard Hose Coupling and Hydrant Fitting" to be used for public fire service.

Mr. Griswold became a member of The American Society of Mechanical Engineers in 1914. He was also a member of the Grand Army of the Republic, the American and New England Water Works Associations, an associate member of the International Association of Fire Engineers, and an honorary life member of the National Fire Protection Association.

Louis E. Strothman, A.S.M.E. Vice-President, Dies in Milwaukee

Louis E. Strothman, Vice-President of the Society, died at his home in Milwaukee, Wisconsin, on May 8, 1922, after an illness of some months. Mr. Strothman was born in Milwaukee in 1879 and received his education in the public schools there and at St. John's Military Academy. From 1899 to 1902 he served as draftsman for several Milwaukee concerns, and then entered the employ of the Allis-Chalmers Manufacturing Co., with which he was associated in various capacities until August, 1919. At that time he became vice-president and general manager of the Richardson-Phenix Co., which position he held until his death.

Louis E. Strothman

Mr. Strothman had an extensive and varied engineering experience. He was a member of a number of engineering societies, including the American Society of Civil Engineers, the American Waterworks Association, the National Association of Stationary Engineers, and the Engineers Society of Milwaukee, of which latter he was president in 1916–17. In 1916 he was appointed a member of the board of directors of the Organization for National Preparedness for the state of Wisconsin, and was also appointed an associate member of the Naval Consulting Board.

He became a member of The American Society of Mechanical Engineers in 1909 and has taken an active interest in its affairs. In 1915–16 he was chairman of the Milwaukee Section. He served as chairman of the 1917 Nominating Committee and has since that time been a member of the Main Committee on Power Test Codes and chairman of the individual committee on Reciprocating Displacement Pumps. In 1919 he was appointed by President Cooley to represent the Society in company with himself on the National Industrial Conference Board. Later in the same year he was elected manager of the Society to fill a vacancy for a year. In 1921 he was elected Vice-President of the Society, which office he was holding at the time of his death.

The Council of the Society, at the Spring Meeting at Atlanta, Ga., received the news of Mr. Strothman's death with great regret, and voted to appoint a special committee to draw up resolutions to be entered upon the records of the Society and to be sent to his family.

From a close friend of Mr. Strothman's, Henry A. Allen, consulting engineer, Chicago, we have received the following appreciation: "Louis E. Strothman was a gentleman and an excellent engineer, always striving to increase his knowledge and to better the engineering profession. When manager of the pumping-engine department of the Allis-Chalmers Co. about twenty years ago, I had the opportunity of advancing him from the drawing board to the desk, where he handled the estimates and correspondence dealing with centrifugal pumps. He was very efficient and his rise from that time on to manager of the department was deserved and steady. His death was a distinct loss to the engineering profession, and to me and many others means the loss of another long-time dear friend."

Atlanta Papers Elicit Valuable Discussions

Contributions on Fuels, Power and Textile Machinery Prove to be Especially Noteworthy. Dr. Stumpf is Present. Atlanta Section Provides Enjoyable Entertainment Program

WITH a happily balanced technical and social program, preceded by an interesting trip to the University of Virginia at Charlottesville and followed by instructive trips to Greenville, S. C., Birmingham, Ala., and Muscle Shoals, the 1922 Spring Meeting of the American Society of Mechanical Engineers will go on record as the most interesting so far in the Society's history.

The meeting was essentially Southern and the Atlanta Section had carefully planned the entertainment program with hospitality achieved only by the open-hearted. Every detail for the comfort of the guests was amply safeguarded and the 350 who registered enjoyed every moment of their sojourn in Atlanta.

The social and entertainment features were described at length in the A.S.M.E. News for May 22, and a more complete account of the discussions presented at the Atlanta Technical Sessions will appear in later issues of MECHANICAL ENGINEERING.

On Tuesday, the first day of the professional sessions at the meeting, there were four simultaneous attractions. Three of the power test codes were presented for public hearing, and a small group of engineers entered earnestly into the discussion, although no fundamental changes were suggested. The codes presented were, Definitions and Values, Displacement Compressors and Blowers, Hydraulic Power Plants and their Equipment.

There was a large attendance at the first general session, which was presided over by Earl F. Scott, of Atlanta. The paper by Alfred Cotton of St. Louis, Mo., on the Accuracy of Boiler Tests attracted considerable attention and elicited a great many criticisms and comments on the subject matter of the paper. E. R. Fish of St. Louis made the presentation. The feature of the session, however, was the paper entitled Using Exhaust Energy In Reciprocating Engines which had been prepared by Dr. J. Stumpf of Charlottenberg, Germany and C. C. Trump of Syracuse, New York. Mr. Trump presented the paper and was followed in the discussion by Dr. Stumpf, who arrived from Germany in time to reach Atlanta for the meeting. This paper also drew out interesting discussion.

At the session on Materials Handling, which was presided over by R. M. Gates, chairman of the Materials Handling Division, F. L. Estep, Chief Engineer of the firm of Perin and Marshall of New York, presented a paper prepared by F. L. Leach, on the subject of Handling Equipment as Used in the Iron and Steel Industry. Mr. Leach is at present in India engaged in work for Perin and Marshall. This paper recorded the most important handling methods used in the iron and steel industry and brought out discussion as to the economies that may be obtained by the use of machinery in materials handling.

In the absence of Charles T. Plunkett, H. M. Latham, of Worcester, Mass. presided at the first session on Textile Machinery. The papers were those on Cotton-Ginning Machinery by S. E. Gillespie of Dallas, Texas and on the Maintenance Textile Machinery by E. H. Marble of Worcester, Mass.

On Tuesday afternoon a number of members and guests visited the plant of the Atlantic Steel Company, which is entirely equipped for the burning of pulverized coal.

On Wednesday there were three simultaneous sessions. A goodly crowd enjoyed the papers presented at the Fuels Session, which was presided over by F. R. Low of New York. The paper by F. G. Cutler of Birmingham, Ala., on the Reduction of Fuels Waste in the Steel Industry proved to be of great interest. E. A. Uehling of Milwaukee, Wis. was not present to give his paper on the Control of Boiler Operation, but the large number of discussions that were entered proved conclusively that the subject was one of great interest. Boiler Room Performance and Practice at Colfax Station of the Duquesne Light Company by C. W. E. Clarke, of New York, N. Y. brought forth a good round of comment from men engaged in boiler-plant operation.

The second session on Textile Machinery was presided over by H. M. Latham who because of the death of L. B. Jenckes of Worcester, Mass., also presented the paper on Weaving Machinery. The other papers at the session were Extraction of Oil from Vegetable Matter, by Joseph Davidson of Atlanta and Modern Shop Practice in the Building of Revolving Flat Cards, by F. E. Banfield, Jr. of Newton Upper Falls, Mass. All the papers were earnestly discussed by the crowd of textile engineers present.

The Management Session on Thursday, presided over by L. P. Alford was devoted to the discussion of two papers; Management Applied to Textile Plants by George S. Harris of Atlanta and The Southern Worker, His History and Character, by Frank H. Neely, also of Atlanta.

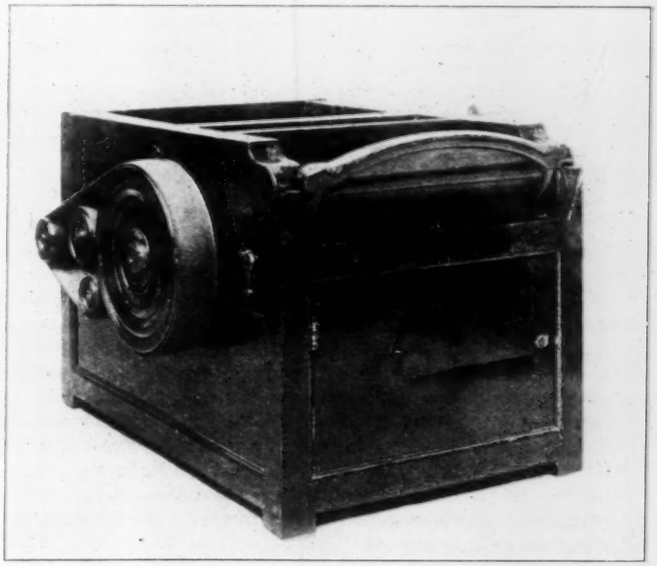
D. W. Mead of Madison, Wis. acted as chairman at the Power Session, which treated some phases of the development of hydro-electric power. Three papers on this subject were presented as follows: Power Development in the Southeast, by Chas. G. Adsit of Atlanta, Economics of Water-Power Development, by C. A. Mees, of Charlotte, N. C., Hydroelectric Power-Plant Design, by John A. Sirnit of Birmingham, Ala. The paper by Messrs. H. B. Reynolds and W. F. Hovey both of New York, which reported the Tests of a 60,000-KW., Cross-Compound, Triple-Cylinder Steam Turbine, was presented by title.

A host of engineers vitally interested in the problems of welding pressure vessels attended the session at which four papers on this subject were presented. Mr. E. R. Fish of St. Louis, presided over the presentation and discussion of these papers. The papers are as follows: Strength of Electrically Welded Pressure Containers, by R. J. Roark of Madison, Wis., Some Principles of the Construction of Unfired Pressure Vessels, by S. W. Miller of Rochester, N. Y., Steel for Forge Welding, by F. N. Speller of Pittsburg, Pa., Tests on Welded Cylinders, by E. A. Fessenden and E. J. Bradford, both of State College, Pa.

Whitney's First Model of His Cotton Gin

A unique feature of the A.S.M.E. Spring Meeting at Atlanta was the exhibition of Eli Whitney's first model of his cotton gin. This model is owned by his grandson, the present Mr. Eli Whitney of New Haven, Conn., who very generously loaned it for the benefit of those attending the Meeting.

Eli Whitney was born in Westboro, Mass., in 1765 and was graduated from Yale College in 1792. In the fall of that year he was en-



ORIGINAL MODEL OF ELI WHITNEY'S COTTON GIN

gaged as a private tutor in a family in Georgia. On his way there he met Mrs. Greene, the widow of Gen. Nathaniel Greene, who was returning to Savannah from a visit north. On reaching Georgia he found that, despite his engagement, another had been given his place and he was stranded, practically penniless. Mrs. Greene invited the young man to her home until he could find something to do.

Shortly after Whitney's coming, a party of gentlemen from Augusta in the upper country, who had been officers in the Revolution under Gen. Greene, were visiting there. The conversation turned to the depressed state of agriculture in the South. Long-staple cotton had been introduced successfully in the sea islands, but could not be grown inland. Short-staple cotton would grow inland, but was unprofitable as there was no practical means of separating the cotton from the seed. The separation by hand of one pound

Same Model Partly Disassembled to Show Mechanism

of staple was a day's work for one woman. During the conversation Mrs. Greene told those present that Mr. Whitney could invent a machine for them that would do the work. This incident turned Whitney's attention to the subject. He went to Savannah, obtained a small parcel of raw cotton and set himself to work on the problem. With the resources the plantation afforded and such tools as he could contrive, he developed the invention in a few weeks and produced his first model, which is exhibited here. This model contains the three essential elements of all cotton gins: namely, the revolving cylinder with forward-pointing teeth; the comb through which the teeth pull the cotton; and the revolving brush to clear the cotton from the teeth.

The cotton gin is justly rated as one of the major inventions in history. No other great invention is so clearly and unmistakably attributable to the work of one man. The modern cotton industry may be said to date from this invention.

For Wartime Government Work, F.A.E.S. Committee Recommends Cost-Plus Contract with Adjusted Compensation

During April the F.A.E.S. Committee on Types of Government Contracts submitted a report after giving careful consideration to a large number of suggestions invited from contractors and other interested individuals.

An abstract of the report is given below. The committee is made up of A. P. Davis, Chairman, Colonel Sherrill, D. Knickerbocker Boyd, Charles E. Ruffner, N. M. McFarland and P. Junkersfeld.

After due discussion the Committee reached the conclusion that all Government contracts should, in the interest of the Government, aim at certain definite objects:

1 The enlistment of the interest of the contractor on behalf of of economy and promptness of execution;

2 Elimination of uncertainties and of hazard to the contractor;

3 Elimination, so far as possible, of opportunities for friction or favortism.

For the purpose of the report it was deemed advisable to divide contracts into three general classes:

1 Contracts for purchase of material and supplies upon which specifications can be nearly exact and few uncertainties are involved;

2 Contracts for construction in which conditions are accurately known and specifications may be exact, such as war vessels, guns, public buildings, etc.;

3 Contracts for construction where many uncertainties are involved, such as character of material, weather conditions, etc.

In the purchase of materials it is desirable that so far as possible, these be made on the basis of test, so that the material purchased will be paid for in accordance with its value. The same principles can be usefully applied to some forms of construction. An example may be cited in the case of ship construction, where it is always desirable to obtain the highest practicable speed within reasonable limits of cost.

The field of structural work is the one to which the Committee gave most attention and in which there is most controversy concerning proper policies.

Much has been said regarding the desirability of standardizing Government contracts and the general tendency of the times is very properly in many fields towards standardization, but it is the opinion of the committee that taking into consideration all of the conditions to be met in the various departments, the extent to which governmental contracts can be standardized is limited and in general can be applied only to certain important general provisions of those contracts, such as the method of determining and enforcing damages, the method of settling disputes as to questions of fact, and the method of determining the compensation of the contractors.

In order, however, to facilitate and encourage bidding by responsible persons in the interest of economy to the Government and fairness to the public, such standardization as is possible should be secured through coöperation between the governmental departments.

In summarizing its work, the committee made the following recommendations:

1. That Government work be normally carried out through unit price, or lump-sum contracts, or by the purchase-and-hire method. Where none of the above methods are applicable to conditions, that the cost-plus method be used in which the contractor is refunded the actual cost of the work plus an accorded compensation which increases if the work is done below the estimated cost of the work, and decreases if the work costs more than estimated, but never sinks below zero.

2. That the failure of any bider to demonstrate to the satisfaction of the Government that he has adequate capital, experience, organization and plant effectively to carry out the work to be done, shall be sufficient cause to justify the conclusion that he is not a responsible bidder, and the consequent refusal of the Government to award him the contract.

3. That there be appointed by the President an inter-Departmental Board on Standardization of Contracts, consisting of one representative of each Government deparment engaged in construction. That this board recommend policies to govern in the standardization of contracts within each department. Each department should have a small board representative of each bureau engaged in construction, and should seek to unify and standardize contract practices within the Department, and the Chairman of these Departmental Boards might preferably constitute the inter-Departmental Board, which should only be advisory in character. That when the contracts of each department shall have been by itself thus standardized, that the inter-Departmental Board consider these contracts and make necessary recommendations to harmonize and secure, so far as feasible, uniformity of practice in the different departments.

4. That it be recognized as the preferable practice that government contracts be so drawn as to place the burden of unforseen contingencies, as far as possible, on the government in the interest of economy to the government in the long run and fairness to the bidders.

5. That all government officials shall recognize the importance of exerting the utmost efforts to make prompt partial payments on government contracts at reasonable intervals as stated in the contracts, for all services rendered and materials delivered by the contractor on the work that has been accepted by the government inspector.

6. That payment shall in all cases, as far as possible, be made by the official or agency directing the work and not by an outside accounting or finance agency, in order to avoid the burden on the contractor of delays in payments when made by such an agency not directly concerned with, or responsible for, the efficiency, economy and dispatch of the work.

7. That boards of arbitration be not in general used to adjust disputes as to facts relating to the execution of government contracts; but that the contractor be given the right of appeal to each of the superiors and the official directing the work, up to the chief of the bureau who may in his dis-

erection appoint a disinterested board of arbitration to determine the facts. In important cases, the contractor should have the right of appeal to the head of department.

8. That deductions for non-completion of contracts on time, so far as practicable, be in the form of liquidated damages and be limited as nearly as possible to the actual damages estimated in advance; that an interpretation of this clause should be made to insure substantial justice, both to the contractor and to the Government in a spirit of liberality. The decision as to the imposition of the liquidated damages should rest in all cases with the technical or professional official or agency directing the work, and not with the clerical or accounting agency.

9. That the Government should take no cognizance of subcontractors further than to see that the principal contractors make prompt payment for all services rendered and materials furnished by the subcontractors. That the disbursing officer may suspend payments to the principal contractor until this is done.

Engineers Are Requested to Provide Contracts Stipulating Abidance by Decisions of National Board of Jurisdictional Awards

In making public the report of Rudolph P. Miller, F.A.E.S. representative on the National Board of Jurisdictional Awards in the Building Industry, L. W. Wallace, Secretary of the American Engineering Council emphasizes the fact that Mr. Miller's report shows that the National Board of Jurisdictional Awards has been instrumental in reducing the number of jurisdictional strikes in the building industry in the United States. Mr. Wallace also asks that the F.A.E.S. use its influence towards securing greater recognition of the important decisions made by the Board.

The function of the Board is the settling of controversies between various labor organizations. Mr. Miller's account of the meeting of February 6 to 9, 1922 is of great interest and a résumé of the outstanding features are given here.

In two disputes before it, the Board made awards as follows: first, the erection of grain hoppers and spouts was conceded to the sheet-metal workers when the metal is ten gage or thinner and to the iron workers when thicker than ten gage; and second, elevator constructors were permitted to hoist, lower and place new elevator machinery, iron workers handling the transport of this machinery to the building in which it is to be erected. A third dispute between iron workers and bricklayers regarding the erection of derricks for setting stone was held over for a future meeting.

One troublesome situation created by the carpenters was given careful consideration by the Board for a day and a half. The carpenters do not abide by the Board's award to the sheet-metal workers of the work of setting hollow metal doors. This caused great embarrassment and a committee of the board was appointed to draw up a resolution regarding this situation. This resolution is given in part below as it makes a direct recommendation to the engineering profession:

> Your committee appointed to outline a procedure to be followed in clearing up the situation created by the failure or refusal of the United Brotherhood of Carpenters and Joiners to conform to the decisions of your Board, as brought to your attention by a committee of the Associated General Contractors, has given careful consideration to the matter.
>
> Some of the decisions in question were rendered more than a year ago. All parties to the plan of the Jurisdictional Board, with the exception noted have endeavored to comply with all its decisions. Of these seventeen International Unions that constituted the Building Trades Department at the inception of the Board sixteen have unqualifiedly endorsed its work and supported its decisions. The seventeenth, namely the Carpenters' Union, has been suspended from the Building Trades Department because of its refusal to abide by those decisions. Some more definite action on the part of those loyal to the plan of the Jurisdictional Board seems desirable and necessary. Your committee therefore recommends the adoption of the following resolution:
>
> WHEREAS, the United Brotherhood of Carpenters and Joiners of America has not been observing or conforming to the decisions of the National Board for Jurisdictional Awards in the Building Industry; and
>
> WHEREAS, the attitude of that organization in failing to observe those decisions is seriously embarrassing owners, architects, engineers, contractors and workmen engaged in the building industry, and such a condition tends to increase costs and to cause delay and is detrimental to the public interest and the building industry in general; and
>
> WHEREAS, all parties signatory to the plan of the Jurisdictional Board have been actively supporting the decisions of that Board, including sixteen of the seventeen International Unions constituting the Building Trades Department at the inception of the Board;
>
> *Resolved*, That in order to correct the above mentioned conditions, the several signatories to the plan of this Board be urged to instruct their constituent members, each in its respective field as follows:
>
> That the members of the American Institute of Architects and of the Federated American Engineering Societies insert in all specifications and contracts for building operations a stipulation that the decisions of the Jurisdictional Board shall be observed:
>
> That the members of the Associated General Contractors and of the National Association of Building Trades Employers incorporate in their agreements with their subcontractors a provision that will secure a compliance with all decisions of the Jurisdictional Board and that the members thereof shall refuse employment to any local union or members thereof neglecting or refusing to abide by decisions of the Jurisdictional Board;
>
> That the Building Trades Department shall instruct local councils to unseat any local union refusing compliance with such decisions, and that associated International Unions shall instruct their respective locals to extend neither recognition nor support until such time as delinquent locals accept and abide by all decisions of the Jurisdictional Board;
>
> *Resolved* further, That this resolution shall be enforced as expeditiously as possible beginning with those localities in which the trouble appears to be most acute and where action seems most urgent and that all these signatories make special and united efforts toward securing general and complete compliance with all the decisions of the Jurisdictional Board; and
>
> *Resolved* also, That as and when trouble in any locality is brought to the attention of any of the signatories such organization shall take the initiative in forming a general committee of representatives from all the signatories for the purpose of dealing with the situation in that locality.

The resolution as will be noted, urges the Federated American Engineering Societies to instruct all firms or individuals who are members of any of its constituent societies and who are engaged in building work, to insert in all specifications and contracts for building operations, a stipulation that the decisions of the Jurisdictional Board shall be observed. The American Institute of Architects has also been requested to do this with its members. There is no doubt but that this will help to an enormous extent, if not in the elimination of trouble coming from jurisdictional disputes. It is not uncommon at the present time, for architects and engineers to incorporate in their specifications, that disputes as to the meanings of those specifications shall be submitted to arbitration, and even in many cases to certain individuals named in the specifications as arbitrators.

NEWS OF OTHER SOCIETIES

SOCIETY OF INDUSTRIAL ENGINEERS

The Influence of Industrial Engineering upon the Earnings of Capitol and Labor was the major subject of the eighth national convention of the Society of Industrial Engineers held at Detroit April 26, 27 and 28. Sessions were held by groups devoted to production, education, industrial relations, executive management, sales management and accounting.

In his presidential address, Prof. Joseph W. Roe, head of the department of industrial engineering of New York University, cited the report of the Committee on Elimination of Waste in Industry as evidencing the need of some method of measuring the effectiveness of management. He declared that there was more need for measuring the effectiveness of management than for measuring any other element in industry, and discussed the phases of it that are measurable and those that may not be.

Some other topics discussed were: The Influence of Industrial Engineering upon Manufacturing Plants, by E. Karl Wennerlund; How Industrial Engineering Serves the Chief Administrator, by Col. Benjamin A. Franklin; How Industrial Engineering May Serve the Executive, by E. W. Hulet; Practical Tests of Employees, by Henry C. Link; The Conservation of Material, by L. Moorehouse and E. J. Schmidt; The Conservation of Plant and Equipment, by F. H. Lowe and A. S. Cunningham; The Conservation of Labor, by Frank B. Gilbreth; Developments in Waste Elimination in the Field of Fatigue; by Norval A. Hawkins; Sales Management and Industrial Engineering, by Daniel B. Gauchet; and How Industrial Engineering Increases the Productivity of Each Industrial Unit at Reasonable Cost, by Parker A. Sowden.

The industrial relations' group discussed Experience with Employees' Representation Plans during the Periods of Business Depression; the managing executives' group discussed Managerial Red Tape; the accountants' group discussed With the Establishment of an Effective Budget Control, What Non-Essentials Can be Eliminated from Present Industrial Accounting, and the sales managers' group, Educating the Distributor.

A feature of the convention was the inspection of the big industrial plants of Detroit. An informal banquet was held on the evening of April 27 at which Matthew Woll, vice-president of the

American Federation of Labor spoke on How Industrial Engineering Can Serve Labor. President Roe presided at the banquet and other speakers included Robert B. Locke of the Federal Reserve Bank, Detroit, and Howard E. Coffin, vice-president of the Hudson Motor Co.

National Metal Trades Association

The program at the twenty-fourth annual convention of the National Metal Trades Association, held at the Hotel Astor, New York City, April 19 and 20, covered a wide range of subjects that dealt in a realistic way with many industrial problems of national and international importance.

Among the questions discussed were the stabilization of Europe and its bearing on domestic business; the relation between the railroads and their patrons; dealings between employers and employees; and coöperation between the farmer and the manufacturer. The report of a recent survey among plants of the members of the Association, which compared conditions as they exist at the present time, a year ago, and in 1914, was one of the most interesting features of the program. It revealed the fact that during the past year no strikes occurred at any of the plants of the members of the Association. The belief was expressed by the president, however, that the coming year, with its necessary further readjustment in wages, may not be so free from disturbances in the metal industry. It was predicted that normal wages will be considerably above the prewar plane. Additional information on this subject was brought out in an address on Facts and Fancies about Wages in Basic American Industries, by N. W. Alexander, of the National Industry Conference Board.

American Society of Civil Engineers

The Spring Meeting of the American Society of Civil Engineers was a three-day meeting devoted to Flood Problems. The meeting was held at Dayton, Ohio, on April 5, 6, and 7, with the technical sessions at the Engineers' Club, and was the first Spring Meeting which the Society has held.

The technical program was given at the three sessions held on the first day of the meeting. The remaining two days were devoted to excursions to nearby points of particular interest to those who were in attendance. The papers presented were: Flood Conditions in Canada, by J. G. Sullivan, President of the Engineering Institute of Canada; Floods on Small Streams Caused by Rainfalls of the Cloudburst Type, by Gerard H. Matthes; Standing Waves in Rivers, by N. C. Grover, chief hydraulic engineer, U. S. Geological Survey; Flood Problems in China, by John R. Freeman, President, A.S.C.E.; Methods in Flood Prevention in the Mississippi Valley, by J. A. Ockerson, member Mississippi River Commission; Relation of Flood Problems to Power and Irrigation Development in the Rocky Mountain States, by A. P. Davis, director U. S. Reclamation Service; Flood Prevention Methods on the Pacific Slope, by C. E. Grunsky, Vice-President A.S.C.E.; and Flood Problems of the Miami Valley and Their Solution, by Arthur E. Morgan and Charles H. Paul, former chief engineer and chief engineer, Miami Conservancy District.

On Thursday and Friday excursions were made to Englewood Dam, Huffman Dam, McCook Aviation Field, the National Cash Register Company's plant, which was the center of relief activities during the flood of 1913, and the American Rolling Mill plant at Middletown. Inspection was also made of the Dayton Channel Improvement work. The Englewood and Huffman Dams are two of the five hydraulic-fill dams that have been built for flood control in the Miami Valley. McCook Aviation Field is the center of research and engineering work in aeronautics for the U. S. Government.

At the dinner and smoker at the Miami Hotel on Thursday evening, Col. E. A. Deeds, president of the Dayton Engineers' Club and chairman of the Board of Directors of the Miami Conservancy District, spoke on Human Phases of the Miami Conservancy Project.

American Gear Manufacturers' Association

A three-day program devoted largely to the technical phases of gearmaking was carried out at the sixth annual convention of the American Gear Manufacturers Association held at the Lafayette Hotel, Buffalo, N. Y., April 20–22. Among the papers of a technical nature that were presented and discussed were: The Use of the Projection Comparator in Testing Gear Teeth (illustrated), by Ralph E. Flanders; Proportions of Industrial Gears, by G. E. Katzenmeyer; The Grinding of Gear Teeth and its Future, by R. S. Drummond; Good Hob Practice, by H. E. Harris; and Bevel Gears, by F. E. McMullen and T. M. Durkon.

Reports were delivered from the standardization committees but no definite action was taken on this phase of the work of the Association. George L. Markland, Jr., of the Philadelphia Gear Works, and R. P. Johnson, of the Worm Gear Co., Muncie, Ind., were the leaders of a general discussion on business conditions. The conditions of the automobile industry, particularly as they affect the gearmaking trade, was one of the main topics discussed at this session. Although it was agreed that nothing approaching a business "boom" was to be expected, the general tone of the meeting was optimistic.

Book Notes

Abriss der Lehre von den Erzlagerstatten. By Richard Beck; prepared by Georg Berg. Gebruder Borntraeger, Berlin, 1922. Paper, 7×10 in., 408 pp., illus., $3.60.

During his latter years Dr. Beck had in mind the preparation of an abridgment of his well-known treatise on ore deposits which would be suitable as a college textbook and a survey of the principal information on the subject for use by geologists whose chief interests lie along other lines. With this in view, he had corrected and annotated a copy of the third edition of the treatise, when his death in 1919 made it necessary to entrust the preparation of the present work to Mr. Berg, one of his earliest assistants.

This outline is approximately one-third the size of the original work, which it follows in plan and arrangement. Condensation has been effected in the different chapters by bringing together the less important occurrences, that are interesting for geological or other reasons, as examples in a general description of the corresponding groups of deposits. The number of ore formations has been reduced by combining certain groups, and the chapter on epigenetic deposits has been shortened.

Analysis of Fuel, Gas, Water and Lubricants. By S. W. Parr. Third edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×8 in., 250 pp., illus., diagrams, tables, $2.50.

This book was originally published for use by students of mechanical engineering, and provided a course intended to help the engineer to a better understanding of the literature of the topics treated, and also to an appreciation and more intelligent use of data supplied by the chemist. The present edition has been expanded to meet the needs of students of chemistry as well. It contains a synopsis of the author's lectures on fuel, gas, water and lubricants, and a course in laboratory methods for their analysis.

Automatic Telephone Systems. By William Aitken. Vol. 1. Circuits and apparatus as used in the public services. Benn Brothers, Ltd., London, 1921. Cloth, 8×10 in., 282 pp., diagrams, 25s.

The great mass of detail and the complicated circuit diagrams required to present this subject make special treatment necessary, if a treatise is to be suited to the needs of students. This book attempts to present the subject in intelligible form by rearranging the diagrams, eliminating unnecessary crossing lines, simplifying the form and presenting them in such a way as to show the relationship of the system as a whole. To accomplish these ends a large page and a new system of describing the diagrams, which consists in numbering a circuit from end to end with the same system, have been used. The book covers the whole subject. The principal commercial systems and other less known systems of promise are described.

Continuous Wave Wireless Telegraphy. By B. E. G. Mittell. (Pitman's technical primers.) Sir Isaac Pitman & Sons, Ltd., London and New York, 1922. Cloth, 4×7 in., 110 pp., illus., $0.85.

This little book is offered as an introduction to radiotelegraphy from the engineer's point of view. It avoids the use of mathematics and plunges directly into the subject without a preliminary discourse upon electricity or the development of mechanical analogies. Special attention, so far as space permits, is given to the Poulsen arc and to the construction of tall aerial structures, and useful references to important papers are given throughout the book.

THE ENGINEERING INDEX

(Registered United States, Great Britain and Canada.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENT PREVENTION

Methods and Limitations. Limitations and New Methods of Accident Prevention (Grenzen und neue Wege der Unfallverhutung). Karl Hartmann. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 8, Feb. 25, 1922, pp. 186–188. Conditional and unconditional protection. Technical and economic limitations. Development of protective regulations. Necessity of cooperation between machine constructor, manager and workman.

AERIAL PHOTOGRAPHY

Fairchild Camera. Aerial Photography. W. L. Hamilton. Aerial Age, vol. 15, nos. 1 and 2, Mar. 13 and 20, 1922, pp. 6–7 and 36–38, 7 figs. Mar. 13: Discusses a map of New York taken from an airplane, and the Fairchild camera with which it was made. Mar. 20: Discusses several examples of successful aerial photography.

AERONAUTICAL INSTRUMENTS

Telecompass. A Solution of the Problem of Determining Position in an Airplane (Une solution du problème de l'orientation en avion). Industrie Électrique, vol. 31, no. 710, Jan. 25, 1922, pp. 25–27, 4 figs. Mechanical and electrical description of the telecompass, and its use.

AIR COMPRESSORS

Modern. Modern Compressors (Les compresseurs modernes). A. Lambrette. Technique Moderne, vol. 13, nos. 11 and 12, Nov. and Dec. 1921, and vol. 14, no. 2, Feb. 1922, pp. 468–474, 502–510 and 59–63, 48 figs. Discusses single-acting, double-acting, monocylindric-two-phase, two-stage, and multiple-stage compressors; inlet and outlet valves; lubrication; play in bearings and connecting rod; etc.

Portable Oil-Engine-Driven. A Portable Air Compressor for Industrial Use (Groupe motocompresseur transportable pour usages industriels). J.-A. Calmettes. Génie Civil, vol. 80, no. 4, Jan. 28, 1922, pp. 87–88, 2 figs. Describes the Diatto compressor driven by an oil engine, for drilling, boring, etc.

AIR CONDITIONING

Gas-Absorption Device. A New Device for Gas Absorption. H. E. Robertson. Chem. Age (N. Y.), vol. 30, no. 2, Feb. 1922, pp. 59–60, 2 figs. Construction and operation of new air conditioner and purifier adapted to many industrial processes involving handling of gases.

AIRCRAFT

Designing Parts. Improved Method for Designing Aircraft Parts. Roy G. Miller and F. E. Seiler, Jr. Aviation, vol. 12, no. 13, Mar. 27, 1922, pp. 366–367, 2 figs. Practical method for determination of elements of irregular structural sections.

Fuels. See GASOLINE.

Research. Research from the Designers', Constructors' and Users' Points of View. Fred M. Green. Flight, vol. 14, no. 8, Feb. 23, 1922, pp. 121–122. Discusses problems of wing surface, power required, metal construction, calculations of stresses, engine design, fuels, navigation, etc. (Abstract.) Paper read before Air Conference, 1922. See also Aerial Age, vol. 15, nos. 1 and 3, Mar. 13 and 27, 1922, pp. 8–9 and 61–62.

Specialized. Specialized Aircraft. W. D. Beatty. Aeronautical Jl., vol. 26, no. 135, Mar. 1922, pp. 92–101 and (discussion) 101–107. How heavier-than-air aircraft has been developed in England on specialized lines, with special reference to comfort of passenger.

AIRCRAFT CONSTRUCTION MATERIALS

Fabric Coverings. Deterioration of Aeroplane Fabrics. Fr. Wendt. Aerial Age, vol. 14, no. 25, Feb. 27, 1922, p. 593. 32nd report of German Experimental Inst. for Aviation at Berlin-Adlershof. Series of experiments were carried out on effect of weathering on cloth covering of airplane wings and fuselages. From Zeit. fur Flugtechnik u. Motorluftschiffahrt, Nov. 30, 1921, p. 325.

AIRPLANE ENGINES

Developments. Recent Aircraft Engine Developments. C. Fayette Taylor. Soc. Automotive Engrs. Jl., vol. 10, no. 3, Mar. 1922, pp. 204–206, 5 figs. Outlines most important advances in aircraft engines since signing of armistice. Use of anti-knock compounds; aircraft-engine size and cooling; aircraft powerplant refinement.

Maybach. Performance of Maybach 300-Horsepower Airplane Engine. Nat. Advisory Committee for Aeronautics, report no. 134, 1922, 11 pp., 24 figs. Deals with results of test made in altitude chamber of Bur. of Standards. From standpoint of thermal efficiency, full-load performance is excellent at densities corresponding to altitudes up to 15,000 ft.; at part load thermal efficiency is low.

AIRPLANE PROPELLERS

Performance. Graphic Calculation of Performances of Air Propellers According to Model Tests (Zeichnerische Berechnung der Leistungen von Luftschrauben nach Modellversuchen). Adolf Rohrbach. Zeit. fur Flugtechnik u. Motorluftschiffahrt, vol. 13, no. 5, Mar. 15, 1922, pp. 61–63, 2 figs. New nomogram is developed to supplement graphic calculations of Durand and Lesley in U. S. Nat. Advisory Committee for Aeronautics Reports nos. 14, 30, 64 and 109.

AIRPLANES

Aerofoils. Properties of Two Aeromarine Aerofoils. B. V. Korvin-Kroukovsky. Aviation, vol. 12, no. 11, Mar. 13, 1922, pp. 314–315, 2 figs. Development of two high-lift wings for use on large aircraft, particularly adapted for performance at large incidence.

Center of Pressure Coefficients for Aerofoils at High Speeds. W. S. Diehl. Nat. Advisory Committee for Aeronautics Technical Notes, no. 25, Apr. 1922. 2 pp., 3 figs. It has been customary to calculate strength of rear wing beam for "high-speed" condition on assumption that center of pressure was at 0.50 of wing chord. It is shown that this assumption is not justified.

Altimeter and Air Speed Indicator. The Dugit Altimeter and Air Speed Indicator. J. H. Blakely. Aviation, vol. 12, no. 13, Mar. 27, 1922, pp. 371–372, 3 figs. Discusses instruments based on application of Archimedean spiral which give increased precision and uniform sensitiveness. Translated from Génie Civil.

Commercial. A Gloucestershire Goods Type Commercial Aeroplane. Flight, vol. 14, no. 6, Feb. 9, 1922, pp. 87–88, 1 fig. Tractor biplane, fitted with Rolls-Royce Eagle engine; 360 hp.; 1,600 lb. goods-carrying capacity.

Electric Cables, Directing by. Directing Airplanes by Electric Cables (Le guidage des avions par cables électriques). P. Franck and A. Volmerange. Aeronautique, vol. 4, no. 33, Feb. 1922, pp. 39–47, 17 figs. Describes method by Loth, based on method of directing ships by electric cable, by which landing in fog and "taking of position" are made possible.

Fuel Level Indicator. The Smith Petrol Level Indicator. Flight, vol. 14, no. 8, Feb. 23, 1922, p. 124, 2 figs. Describes new device by S. Smith & Sons, Ltd., Lond., special features of which are simplicity both in construction and operation. Adaptable also for use on reservoirs, storage tanks, etc.

German Commercial. The L. F. G. Commercial Airplane Type V 13 (Das L. F. G.-Verkehrsflugzeug Type V 13). Motorwagen, vol. 25, no. 6, Feb. 28, 1922, pp. 119–120, 2 figs. Characteristics of the Strela, for 2 or 4 passengers: Weight empty, 1460 kg.; total weight, 2128 kg.; max. span, 17.5 mm.; max. length, 10.9 m.; max. height, 3.88 m.; engine, 185-hp. Benz or Bavarian Motor Works engine, or 220-hp. Benz or Mercedes.

1000-Hp. Napier Cub. Harnessing 1,000 Horse Power. Flight, vol. 14, no. 8, Feb. 23, 1922, pp. 118–119, 7 figs. Describes the 1000-hp. Napier "Cub."

Parachutes. See PARACHUTES.

Research. Research With Full Sized Airplanes. F. H. Norton. Tech. Eng. News, vol. 2, no. 9, Mar. 1922, pp. 240–241, 3 figs. Describes some free flight problems recently investigated by Nat. Advisory Committee for Aeronautics, at Langley Field.

Seaplanes. See SEAPLANES.

Speed Calculation in Flight. Graphic Calculation of Airplane Speeds in Straight and Circling Flight (Zeichnerische Berechnung der Geschwindigkeiten von Flugzeugen im Geradeaus- und Kurvenflug). Adolf Rohrbach. Zeit. fur Flugtechnik u. Motorluftschiffahrt, vol. 13, no. 5, Mar. 15, 1922, pp. 59–61, 2 figs. Presents charts and describes method of calculation.

Waco Model 4. The Waco Model 4. Aerial Age Weekly, vol. 15, no. 2, Mar. 20, 1922, pp. 32–34, 2 figs. Describes four-place biplane of Weaver Aircraft Co. of Lorain, Ohio; Curtiss Ox-5 motor; 84 m.p.h. at 1050 r.p.m.

AIRSHIPS

Development and Possibilities. Airships. G. H. Scott. Aerial Age, vol. 14, no. 25, Feb. 27, 1922, pp. 590–593. Airship activities in various countries; technical position of modern British airship, including hull, fabric, engines, safety, weather conditions, and mooring mast; value of airships for defense. Paper read before British Air Conference.

Drag of Hull. The Drag of C Class Airship Hull with Varying Length of Cylindric Midships. A. F. Zahm, H. R. Smith and G. C. Hill. Nat. Advisory Committee for Aeronautics, Report no. 138, 1921, 10 pp., 6 figs. A model of C class airship hull, when severed at its major section and provided with cylindric midbody of variable length, had its air resistance increased about in proportion to length of mid-body up to 3 diameters, and in about manner to be expected from increase of skin friction on this variable length. For greater length drag increased less and less rapidly.

Model Tests. Hydrostatic Test of an Airship Model. Nat. Advisory Committee for Aeronautics Technical Notes, no. 87, Mar. 1922, 15 pp., 8 figs. on supp. plates. Airship model made by Goodyear Rubber Co. was filled with water and suspended from beam and deformations of envelope studied under following conditions: both ballonets empty; forward ballonet filled with air; rear ballonet filled with air; and both ballonets filled with air.

R 38 Accident. British Report on the Loss of Airship R38. Aviation, vol. 12, no. 11, Mar. 13, 1922, pp. 311–312. Findings of Aeronautical Research

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NOTE.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

Committee attribute accident to inaccurate calculations, faulty design and structural weakness.

Speed. The Choice of the Speed of an Airship, Max M. Munk. Nat. Advisory Committee for Aeronautics Technical Notes, no. 89, Mar. 1922, 8 pp., 2 figs. Presents fairly simple rules which it is claimed may be of advantage if reasonably applied.

ALCOHOL

Dilute Solutions. The Vapour Pressures of Dilute Alcohol Solutions, R. Thomas. Soc. Chem. Industry Jl., vol. 41, no. 4, Feb. 28, 1922, pp. 33T–34T, 2 figs. Describes rapid method of determining partial pressures of alcohol and water in an aqueous solution of former.

ALLOY STEELS

Vibrac. Vibrac Steel. Motor Transport, vol. 34, no. 888, Mar. 6, 1922, p. 287, 1 fig. Describes properties and tests of new steel produced by Armstrong, Whitworth & Co., which is proof against temper-brittleness.

ALLOYS

Aluminum. See ALUMINUM ALLOYS.

Copper. See COPPER ALLOYS.

Ternary and Quaternary. The Graphic Presentation of Ternary and Quaternary Alloys (Die graphische Darstellung von Dreistoff- und Vierstoff-Legierungen), W. Hommel. Zeit. fur Metallkunde, vol. 13, nos. 13, 14 and 15, Oct. Nov. and Dec. 1921, pp. 456–465, 511–518 and 565–569, 22 figs. Development of new method for diagrammatic presentation of such alloys. The concentration and melting temperature for each alloy can be read immediately in diagram. Construction of diagrams for different systems.

Treatment. Modern Metal Alloys and Their Treatment (Neuere Metallegierungen und ihre Verarbeitung), Willy Hacker. Elektrotechnischer Anzeiger, vol. 39, nos. 2, 3 and 5, Jan. 4, 5 and 10, 1922, pp. 8–10, 14–16 and 35–37. Review of modern German processes for preparation and treatment of alloys.

ALUMINUM ALLOYS

Failures. Some Cases of Failure in "Aluminium" Alloys, W. Rosenhain. Inst. of Metals Advance Paper for meeting Mar. 9, 1922, 4 pp., 2 figs.; also Engineering, vol. 113, no. 2932, Mar. 10, 1922, p. 308, 2 figs. Discusses two examples of failures showing that materials which undergo serious growth, distortion, and disintegration in course of service, are not aluminum alloys in ordinary sense of that term, but materials of essentially different type.

Research. On Some Alloys of Aluminum, Walter Rosenhain and Sydney L. Archbutt. Instn. Mech. Engrs. Proc., no. 7, 1921, pp. 699–725 and (discussion) pp. 727–771. Report to Alloys Research Committee representing result of organized work of practically whole staff of Metallurgical Dept. of Nat. Physical Laboratory. Deals with cast and wrought alloys, permanence and constitution of alloys.

Zinc and Aluminum. A Further Study of the Alloys of Aluminium and Zinc, D. Hanson and Marie L. V. Gayler. Inst. of Metals Advance Paper for meeting Mar. 9, 1922, 28 pp., 29 figs. Account of investigation. Deals with determination of the solidus; constitution of solid alloys; the constituent beta; age-hardening of constituent beta and gamma. Photomicrographs.

AMMONIA COMPRESSORS

Losses. Losses in Ammonia Compressors, S. F. Smith. Refrig. World, vol. 57, no. 3, Mar. 1922, pp. 25–26. The five ways in which losses occur in compression machine and conditions which control same. The two-stage compressor and its field. Paper read before Mountain States Ice Manufacturers Assn.

Starterless Induction Motors for. Starterless Induction Motors for Ammonia Compressors, J. Lebovici. A.S.R.E. Jl., vol. 8, no. 5, Mar. 1922, pp. 398–402 and (discussion) 402–404, 7 figs. Combines favorable characteristic of squirrel cage and slip ring types, and makes ideal drive for ammonia compressors using up to 150 hp.

APPRENTICES, TRAINING OF

System, Rock Island Arsenal. Apprenticeship System at Rock Island Arsenal, William Baumbeck. Am. Mach., vol. 56, no. 14, Apr. 6, 1922, pp. 512–514, 6 figs. Devices for teaching. Use of slide rule. Action of gear teeth and selection of proper views for drawings. Outline of courses.

ASH HANDLING

Hydraulic Disposal System. Handling Ashes by Sluicing, C. C. Lance. Power, vol. 55, no. 13, Mar. 28, 1922, pp. 503–504, 1 fig. Calumet and Hecla Mining Co. power plant at Lake Linden, Mich., reduces ash-handling costs by hydraulic system of ash disposal.

AUTOMOBILE ENGINES

Air Cooling. Air-Cooling Progress in U. S. A., Harold F. Blanchard. Autocar, vol. 48, no. 1376, Mar. 4, 1922, pp. 355–359, 8 figs. Economy in operation important feature. Discusses air cooling as applied to Franklin, Holmes, 6-cylinder Fox, and twin-three D.A.C. cars, and explains how cooling draught is induced.

Buda. A Good Example of Modern Engine Design, J. Edward Schipper. Automotive Industries, vol. 46, no. 13, Mar. 30, 1922, pp. 699–700, 1 fig. New model of Buda engine designed for light commercial trucks and similar applications, but of heavy-duty type and similar in general design to other engines of same make. Compression ratio, 4.35 to 1.

Carburetors. See CARBURETORS.

Crankshafts. See CRANKSHAFST.

Cylinders. Some Aspects of Air-Cooled Cylinder Design and Development, S. D. Heron. Soc. Automotive Engrs. Jl., vol. 10, no. 4, Apr. 1922, pp. 231–260, 35 figs. Design and development of modern high-output air-cooled cylinder. Deals primarily with problems of aircraft cylinder of approximately 40 b.hp.

Development. Aircraft Engine Experience as a Basis for Automobile Engine Development, H. Dechamps. Automotive Industries, vol. 46, no. 11, Mar. 16, 1922, pp. 611–613. Super-compression and over-dimensioning of engines as an aid to fuel economy.

Fuel Economy. Relation Between Fluid Friction and Transmission Efficiency, Neil MacCoull. Soc. Automotive Engrs. Jl., vol. 10, no. 3, Mar. 1922, pp. 193–199, 16 figs. Experiments to determine mechanical losses, including data from E. H. Lockwood's experiments at Yale. Possibilities for increasing fuel economy of a motor vehicle. See also Lubrication, vol. 8, no. 1, Jan. 1922, pp. 1–8, 15 figs.

Ignition, Automatic. Automatic Ignition Advance. Autocar, vol. 48, no. 1376, Mar. 4, 1922, pp. 362–363, 1 fig. Describes mechanism to provide automatic spark advance by depression in inlet pipe, which is very great when throttle is almost closed, but grows less with increase of engine speed, and mechanical compensation moving with throttle mechanism.

Increasing Power Obtainable. The Super-Power Engine, G. Funck. Autocar, vol. 48, no. 1377, Mar. 11, 1922, pp. 395–400, 13 figs. Deals with means of increasing power obtainable from engine of given cubical capacity othet than those ordinarily employed.

Manifold Design. Manifold Vaporization and Exhaust-Gas Temperatures, O. C. Berry and C. S. Kegerreis. Soc. Automotive Engrs. Jl., vol. 10, no. 3, Mar. 1922, pp. 171–176, 10 figs. Discusses low volatility of fuel for internal-combustion engines as cause of uneconomical utilization of fuel and of engine maintenance troubles. Tests carried out.

Stutz. Powerplant in New Stutz Model Incorporates Many Changes, J. Edward Schipper. Automotive Industries, vol. 46, no. 14, Apr. 6, 1922, pp. 750–751, 6 figs. Lighter pistons, redesign of jackets and cylinder head, better fuel vaporizing means, heavier crankshaft, machined combustion chambers, etc.

Two-Stroke. An Investigation of Certain Aspects of the Two-Stroke Engine for Automobile Vehicles, F. W. Lanchester and R. H. Pearsall. Automobile Engr., vol. 12, no. 160, Feb. 1922, pp. 55–62, 16 figs. Investigation of principal factors controlling performance of internal-combustion engines functioning on two-stroke cycle, especially small size engines of simplest forms adapted to work at comparatively high revolution-speeds. Paper before Instn. Automobile Engrs.

AUTOMOBILE FUELS

Alcohol. The Use of Alcohol as Fuel in Exported Vehicles, Herbert Chase. Automotive Industries, vol. 46, no. 14, Apr. 6, 1922, pp. 771–773, 1 fig. Use of alcohol in Spanish-American countries because of less cost, and adaptation of vehicles for use of alcohol. Discusses problems met in its use and suggests remedies.

[See also GASOLINE.]

AUTOMOBILES

Austro-Daimler. The 17/60-Hp. Austro-Daimler Six-Cylinder Car Type AD 617 (Der 17/60 PS-Austro-Daimler-Sechszylinder-Wagen, Type AD 617). Allgemeine Automobil-Zeitung, vol. 23, no. 4, Jan. 28, 1922, pp. 28–30, 7 figs. Dimensions: Max. length, 4.625 m.; max. width, 1.685 m.; max. height, 1.56 m.; wheelbase, 3.45 m.; gage, 1.36 m.; weight of chassis, 1240 kg. Details of engine.

Bianchi 12-20 Hp. The 12-20 Hp. Bianchi Chassis. Automobile Engr., vol. 12, no. 161, Mar. 1922, pp. 66–71, 12 figs. Describes engine, clutch, gearbox, etc., of small car made by Bianchi Motors, Ltd., Milan.

Bodies, Manufacture of. The Efficient Production Automobile Bodies, G. W. Eastwood. Eng. Production, vol. 4, nos. 74 and 75, Mar. 2 and 9, 1922, pp. 200–202 and 221–224, 18 figs. Construction methods. Paper presented before Instn. Production Engrs. See also discussion of paper in same journal, vol. 4, no. 76, Mar. 16, 1922, pp. 248–250.

Brakes. Developing a Method for Testing Brake-Linings, S. von Ammon. Soc. Automotive Engrs. Jl., vol. 10, no. 3, Mar. 1922, pp. 153–162, 23 figs. Describes equipment developed and methods used for tests; coefficient of friction; endurance tests with cooled drum; severe-service test with uncooled drum; etc.

Passenger-Car Brakes, J. Edward Schipper. Soc. Automotive Engrs. Jl., vol. 10, no. 4, Apr. 1922, pp. 273–289, 29 figs. Comprehensive survey of present braking practice and outline of future requirements and possibilities; design factors; future of brakes.

The Perrot-Hallot Brake (Die Perrot-Hallot-Bremse), Claus Syrlin. Allgemeine Automobil Zeitung, vol. 23, no. 1, Jan. 7, 1922, pp. 33–34, 2 figs. Details and principle of automobile brake developed by Hallot and Perrot, tests with which recently carried out under auspices of Royal English Automobile Club showed excellent results.

Gear Boxes. Improvements in Gear-box Design, H. F. L. Orcutt. Automotive Industries, vol. 46, nos. 9, 10 and 11, Mar. 2, 9 and 16, 1922, pp. 511–514, 563–565 and 617–621, 5 figs. Mar. 2: Points out some of usual defects and outlines methods of improvement. Mar. 9: Methods employed to carry on special gear-box gear tests. Describes new gear-tooth grinding process. Mar. 16: Factors in production of gear boxes, and suggestions for improvements in design. Condensed from paper read before Instn. Automobile Engrs.

German Szawe. German Car of Novel Design Employs Many Aluminum Parts, Benno R. Dierfeld. Automotive Industries, vol. 46, no. 13, Mar. 30, 1922, pp. 701–706, 20 figs. Uses six-cylinder, 2.44 by 5.51-in. aluminum alloy engine with thin steel liners cast in block. Outstanding features are an automatic gearshift, and rear axle housing casting and pistons of silumin. Built by Szabo & Wechselmann, Berlin, principally for export trade.

Hubs and Pistons. Tooling Equipment for Automobile Hubs and Pistons, Ralph E. Flanders. Machy. (N. Y.), vol. 28, no. 8, Apr. 1922, pp. 640–644, 16 figs. Describes tools and operations.

Miniature Four-Cylinder. Miniature "Fours." Autocar, vol. 48, no. 1378, Mar. 18, 1922, pp. 431–435, 9 figs. Description of some of best known of modern four-cylinder engines having piston displacements of less than 1,000 cc.

Modern Plant Design. Designing a Modern Automobile Plant, Paul L. Battey. Iron Age, vol. 109, nos. 10 and 11, Mar. 9 and 16, 1922, pp. 652–656 and 713, 14 figs. What is involved in relations of departments and in many services now demanded. View of future in industrial developments. Providing power, heating, water supply and other services. Details of plant and manufacturing procedure of the Willys Corp., Elizabeth, N. J. Based on paper presented before Am. Soc. Mech. Engrs.

Repair Shops. Service in a "White" Station, Fred. H. Colvin. Am. Mach., vol. 56, no. 12, Mar. 23, 1922, pp. 429–432, 9 figs. Layout of Newark, N. J., service station of White Motor Co. Eliminating time waste. Layout of stockroom. Exchange of worn or damaged parts. Facilities for handling motors and other parts.

16-20 Hp. Cubitt. The 16-20-Hp. Cubitt Chassis. Automobile Engr., vol. 12, no. 160, Feb. 1922, pp. 34–40, 15 figs. Low-priced vehicle built on quantity production lines. Described engine, clutch, gearbox, transmission brake, transmission and rear axle suspension, etc.

Star. New Durant Product Makes Good Impression. Herbert Chase. Automotive Industries, vol. 46, no. 11, Mar. 16, 1922, pp. 601–604, 7 figs. Describes new car built for Star Company. Has 102-in. wheelbase; pump circulation; long, semi-eleptic springs; storage battery; etc.; 35 hp. at 2,500 r.p.m.

Steam. A Steam Car That Is Different. Sci. Am., vol. 126, no. 4, Apr. 1922, p. 262, 4 figs. Details of new Coats steam car having gas-car control and finish with steam-car smoothness.

Suspension. A New Suspension System. Auto, vol. 27, no. 7, Feb. 16, 1922, p. 136, 1 fig. Some details of the Gattie device in which helical springs are utilized.

240-Hp. Racing. A 240-Hp. Car For Brooklands. Autocar, vol. 48, no. 1376, Mar. 4, 1922, p. 351, 2 figs. Fitted with Benz aero engine, Hartford shock absorbers and Rudge-Whitworth wire wheels.

AVIATION

Aerial Transportation. Aerial Transport Today and Tomorrow, W. A. Bristow. Aerial Age, vol. 14, no. 26, Mar. 6, 1922, pp. 616–618 and 627 and vol. 15, no. 2, Mar. 20, 1922, pp. 35 and 38. Also abstract in Flight, Feb. 16, 1922, p. 99. Discusses present situation depending on subsidies of some sort, the building up of merchant air fleets as main reliance for military air fleets, and increased passenger traffic required.

Civil. The Air Conference. Flight, vol. 14, no. 6, Feb. 9, 1922, pp. 83–86, 2 figs. Summary of Lord Gorell's paper on Civil Aviation, discussing factors of successful development, service and civil sides, progress, necessity for more research work, cross-channel services, imperial air services, air mails, policy of subsidization, etc.

Marking Aerodromes. Marking Aerodromes, P. James. Aerial Age, vol. 14, no. 25, Feb. 27, 1922, pp. 586 and 588. Necessity of adopting system of markers for giving direction for starting and landing and of indicating good part of field. Methods hitherto employed and methods now proposed. From Premier Congrès Internationale de la Navigation Aérienne, Paris, Nov. 1921, vol. 2, pp. 115–118.

AXLES

Milling Eccentric Keyways in. Device for Milling Eccentric Keyways in Axles of Locomotives After the Axles are Pressed Into the Wheels. Ry. & Locomotive Eng., vol. 35, no. 3, Mar. 1922, pp. 58–59, 3 figs. Details of construction and application.

B

BALANCING

Rotating Masses. Notes on Balancing Rotating Masses, J. W. Rogers. Mech. World, vol. 71, nos. 1832 and 1833, Feb. 10 and 17, 1922, pp. 106–107 and 124–125, 6 figs. Feb. 10: Statical and dynamical balancing. Feb. 17: Describes Martin rotor balancing machine, whose application affords quick, safe and inexpensive method of balancing all types of rotary bodies and gives very accurate results.

BEARINGS, ROLLER

Street Cars. Roller Bearings in the Municipal Street-Railway Cars of Hagen (Germany) (Rollenlager im Betriebe der Hagener Strassenbahn), K. Pforte. Verkehrstechnik, vol. 29, no. 7, Feb. 17, 1922, pp. 80–83, 4 figs. Describes Jaeger type of roller bearings adopted by municipal street railway as substitute for uneconomic journal bearing for motors and axle bearings, and points out their value in reducing cost and increasing safety. Advantages over ball bearings.

BEARINGS, THRUST

Michell. The Michell Bearing. Machy. (Lond.), vol. 19, no. 495, Mar. 23, 1922, pp. 765–766, 4 figs. Application.

BELTING

Power Transmission by. Power Transmission by Belting. W. G. Dunkley. Eng. & Indus. Management, vol. 7, no. 10, Mar. 23, 1922, pp. 280–281, 2 figs. Describes common faults which are met with in works, and suggests methods by which they may be satisfactorily overcome. Notes on belt design, stresses and tension.

BENDING MACHINES

Boiler-Plate. A New Boiler-Plate Bending Machine of Vertical Type with Electric Drive (Eine neue Kesselblechbiegemaschine stehender Anordnung mit elektrischem Antrieb), Hugo Becker. Schiffbau, vol. 23, no. 22–23, Mar. 1–8, 1922, pp. 690–693, 6 figs. Describes new type of bending press for boiler plate which is claimed to show marked improvements and advantages over older types.

BOILER FEEDWATER

Treatment. Advantages of Treating Locomotive Feed Water. Boiler Maker, vol. 22, no. 3, Mar. 1922, pp. 66–68. Quality of boiler water; treatment to prevent scale and plants designed for the purpose; gives questionnaire on water treatment. To be presented at 1922 meeting Master Boiler Makers' Assn.

Treated Water Improves Locomotive Performance, W. A. Powanall. Ry. Mech. Engr., vol. 96, no. 4, Apr. 1922, pp. 191–192. Systematic methods of boiler water treatment by soda ash process.

BOILER OPERATION

Efficient. The Expectation of Efficiency of Steam Boiler Operation, Hugh R. Carr. Power Plant Eng., vol. 26, no. 7, Apr. 1, 1922, pp. 357–360, 2 figs. Discusses variables entering into the question, viz.: type of draft, combustion rate, coal, ratio of heating to grate surface, point of maximum heat intensity. Proposes empirical curves for determining efficiency with fair degree of accuracy.

Rating Percentage. Percentage of Boiler Rating: Power, vol. 55, no. 14, Apr. 4, 1922, pp. 531–532. What it means and how it is figured. Presents table for simplifying computations.

BOILERS

Adaptation to Low-Grade Fuel. Reconstruction of Coke Sectional Boilers for the Burning of Substitute Fuels (Umstellung von Koksgliederkesseln auf Ersatsbrennstoffe), H. Pradel. Braunkohle, vol. 20, no. 45, Feb. 11, 1922, pp. 705–711, 12 figs. Details of improvements in boilers by German boilermakers designed for use of low-grade fuel.

Ambitubular. Ambitubular Boiler (Chaudière ambitubulaire), C. Anguenot. Arts et Metiers, vol. 74, no. 15, Dec. 1921, pp. 357–360, 2 figs. Describes boiler combining water tubes and fire tubes and advantages of both.

Design and Operation. Steam Boilers. F. W. Dean. N. E. Water Works Assn. Jl., vol. 36, no. 1, Mar. 1922, pp. 115–139 and (discussion) pp. 139–140, 5 figs. Notes on internally and externally fired boilers; fire-tube and water-tube boilers; workmanship; baffles; method of taking steam from boilers; height of boilers above floor; height of bridge walls; locomotive-type boilers; feedwater regulators; temperature of escaping gases; mechanical and hand stokers; pulverized coal; oil fuel; feeding boilers; etc.

Electrically Heated. Electrically Heated Boilers (Elektrodampfkessel), H. Schneider. Archiv. fur Warmewirtschaft, vol. 3, no. 2, Feb. 1922, pp. 27–28, 5 figs. Comparison with steam generation with coal firing. Types of electrically heated boilers.

Heat-Loss Determination. A New Method of Determining Heat Losses by Means of the Combustible Gas in the Exhaust Gases of Boilers (Ein neues Verfahren zur Bestimmung der Warmeverluste durch brennbares Gas in den Abgasen der Kesselfeuer), O. I. Hansen. Zeit. des Bayerischen Revisions-Vereins, vol. 26, nos. 1, 2 and 3, Jan. 15, 31 and Feb. 15, 1922, pp. 3–5, 13–15 and 21–22, 4 figs. Describes method and apparatus with which it is possible to determine heat loss with sufficient accuracy. Account of tests carried out by K. E. Nielsen in Copenhagen (Denmark) gas works.

High-Pressure. The Thermo-Dynamics of Extra High Pressure Steam in Connection with Power and Heat Economics, O. H. Hartmann. Eng. Progress, vol. 3, no. 3, Mar. 1922, pp. 45–48, 7 figs. Describes vertical-tube boiler for pressure of 60 atmos. developed by Wilhelm Schmidt, which can generate steam at this atmosphere and up to temperature of 480 deg. cent. Tests with extra-high-pressure steam engines, and importance of these engines for heat economics. Possibilities of application of extra-high-pressure steam in connection with combined power and heating installations.

Locomotive. See LOCOMOTIVE BOILERS

Low-Pressure Gas in Oil-Field. Use of Low-Pressure Gas Burners in Oil-Field Boilers, M. P. Youker. U. S. Bur. of Mines Reports of Investigations, serial no. 2329, Feb. 1922, 8 pp. Résumé of report on possibilities of using low-pressure gas to generate steam for drilling purposes and on types of gas burners which would be best for this purpose.

Welding. Commercial Welding on High Pressure Boilers, Edward H. Heidel. Can. Machy., vol. 27, no. 12, Mar. 23, 1922, pp. 27–28, 5 figs. Procedure and rules to be followed in welding boilers; autogenous welding of locomotives; etc. Paper read before Am. Welding Soc.

BOILERS, WATER-TUBE

Design. Standard Rules Governing The Construction of Water-Tube Boilers. Shipbldg. & Shipg. Rec., vol. 19, no. 11, Mar. 16, 1922, p. 335. Deals with Part V of Standard Conditions for Design and Construction of Marine Boilers and Shafting, prepared by British Marine Engineering Design and Construction Committee.

Reliability. The Reliability of Water-Tube Boilers. Shipbldg. & Shipg. Rec., vol. 19, no. 10, Mar. 9, 1922, p. 299. Editorial dealing with explosion which occurred in one of the water-tube boilers of the Berengaria.

BOLTS

Tightening by Use of Liquid Air. Experimental Use of Liquid Air and Explosives for Tightening Body-Bound Bolts, H. L. Whittemore. Am. Mach., vol. 56, no. 14, Apr. 6, 1922, pp. 524–526. Cylindrical and taper bolts contracted by liquid air and allowed to expand after insertion. Cylindrical bolts expanded in place by explosives.

BORING TOOLS

Chart for Determining Pressure. Chart for Determining the Pressure Exerted by Boring Tools, J. B. Conway. Am. Mach., vol. 56, no. 13, Mar. 30, 1922, pp. 476–478, 1 fig. Describes construction and operation of chart. Determination of end thrust and pressure due to cutting. Table for values of feed to 0.7 power.

BRAKES

Freight-Train. Continuous Brake for Long Freight Trains (Le freinage continu des longs trains de marchandises), J. Netter. Le Génie Civil, vol. 79, nos. 26 and 27, Dec. 24 and 31, 1921, pp. 557–561 and 585–590, 28 figs. Dec. 24: Discusses tests in progress by Commission of French Public Works. Describes situation before and after war, also the Westinghouse triple-valve brake. Dec. 31: The Kunze-Knorr and Lipkowski compressed-air brakes and the Clayton-Hardy vacuum brake. Results of tests carried out.

BRASS

Forgings, Manufacture of. The Manufacture of Brass Forgings, C. T. Roder. Iron Age, vol. 109, no. 13, Mar. 30, 1922, pp. 857–858, 2 figs. Called also die pressing or hot forging. Details of process developed in United States during war. Physical and other properties.

Plasticity Under Compression. Plasticity of Brass Rods Under Percussive Compression, Fr. Doerinckel and Julius Trockels. Raw Material, vol. 5, no. 2, Mar. 1922, pp. 58–62, 16 figs. Discusses occurrence of flow in compressed brass by hydraulic compression of bars, showing that at red-heat vortex motions ensue by pressure in brass block. From Zeit. für Metallkunde.

Season Cracking. Further Studies in Season-Cracking and Its Prevention. Condenser Tubes, H. Moore and S. Beckinsale. Inst. of Metals Advance Paper for meeting Mar. 8, 1922, 22 pp., 11 figs. Record of work done in consequence of suggestion made by George Goodwin, of application to Admiralty condenser tubes of low-temperature annealing recommended for removal of internal stress in brass. See also (abstract) in Engineering vol. 113, no. 2933, Mar. 17, 1922, pp. 337–340, 11 figs.; and Metal Industry (Lond.), vol. 20, no. 13, Mar. 31, 1922, pp. 298–302, 6 figs.

BROACHES

Design. The Design of Pull Broaches, J. Labensky and Palmer Hutchinson. Machy. (N. Y.), vol. 28, no. 8, Apr. 1922, pp. 615–617, 4 figs. Depth of cut, pitch, length, shape of teeth. Methods of attaching broaches to machines.

BUSES

Trolley. The Operation of a Self-Contained Trolley Omnibus System, J. B. Parker. Tramway & Ry. World, vol. 51, no. 13, Mar. 16, 1922, pp. 117–123, 13 figs. Describes operation of system controlled by Tees-side Railless Traction Board, and gives operating costs of new trolley buses.

C

CABLEWAYS

Aerial. Aerial Cableways (Les transporteurs aériens à cables), Cretin. Génie Civil, vol. 80, nos. 4 and 5, Jan. 28 and Feb. 4, 1922, pp. 75–79 and 103–105, 15 figs. Jan. 28: Discusses analytical calculations with examples. Feb. 4: Tension of cableways and calculation of loads.

CAMS

Design. Design of Cams (Einiges uber die Nockenscheiben der Motoren), Arthur Balog. Wirtschafts-motor, no. 12, Dec. 25, 1921, pp. 19–21, 5 figs. It is shown how, for different types of engines (for example, Diesel engines), a uniform basis can be developed for design of uniform, easily made cams.

CAR WHEELS

Chilled-Iron, Manufacture. Car Wheel Manufacture Revolutionized, Gilbert L. Lacher. Iron Age, vol. 109, nos. 13 and 14, Mar. 30 and Apr. 6, 1922, pp. 847–852 and 939–943, 8 figs. Describes practice at plant of Griffin Wheel Co. at Council Bluffs, Iowa. Notes on mechanical molding; charging and handling of cupolas; sand preparation; core making and baking.

Flange Welding. Getting Wheel Mileage Without a Lathe. Elec. Traction, vol. 18, no. 3, Mar. 1922, pp. 214–215, 6 figs. Utilization of welding and cutting torch instead of wheel-turning lathe by Terre Haute, Indianapolis and Eastern Traction Co.

Machining. Machining and Mounting Wheels and Axles, Charles Petrain. Ry. Mech. Engr., vol. 96, no. 3, Mar. 1922, pp. 148–150, 1 fig. Gaging worn axles and rolled-steel wheels; welding cast steel wheels. (Abstract.) Paper read before Car Foremen's Assn. of Chicago.

CARBURETORS

German Types. Carburetors Exhibited at the German Automobile Show 1921 (Die Vergaser auf der Deutschen Automobil-Ausstellung 1921), Joh. Menzel. Allgemeine-Automobil-Zeitung, vol. 22, nos. 43, 44, 45, 46, 47 and 49. Oct. 22, 29, Nov. 5, 12, 19 and Dec. 3, 1921, pp. 24–25, 28–30, 33–35, 34–35, 28–29 and 32–34, 29 figs. Details, advantages and disadvantages of types exhibited.

Problems and Design. The Relation of Carburetion to Fuel Economy, J. N. Golten. Automotive Industries, vol. 46, nos. 12 and 13, Mar. 23 and 30, 1922, pp. 666–669 and 714–717, 14 figs. Mar. 23: Functions of carbureting system; metering characteristics of ideal carburetor; pulsating air flow; carburetor problems and design. Mar. 30: Vaporization from theoretical and practical standpoint.

CARS

British Works. The Nottingham Works of Cammel Laird and Co., Limited. Engineer, vol. 133, no. 3454, Mar. 10, 1922, pp. 268–270, 12 figs. partly on p. 272. Describes shops, equipment and practice of works for production of railway rolling stock. See also Engineering, vol. 113, no. 2932, Mar. 10, 1922, pp. 292–294, 4 figs.

Hose Connector, Automatic. Recent Changes in American Hose Connectors. Ry. Mech. Engr., vol. 96, no. 3, Mar. 1922, pp. 141–143, 4 figs. Manufactured by Am. Automatic Connector Co., Cleveland, Ohio. Passenger heads interlocked under pressure; permanently attached freight interchange adapter.

CARS, COAL

Gondola. C. M. and St. P. Ry. Sets An Example in Good Car Design. Ry. Rev., vol. 70, no. 12, Mar. 25, 1922, pp. 415–420, 5 figs. Particulars of design of new gondola cars of Chicago Milwaukee & St. Paul; 50 tons capacity; weight, 40,400 lb.

CARS, FREIGHT

Interchange. On the Question of Interchange of Rolling Stock (all countries except America), M. Charron. Int. Ry. Assn. Bul., vol. 4, no. 3, Mar. 1922, pp. 479–535. Report on interchange of goods rolling stock (freight cars), and penalty charges in case of delay in return of that stock; rules to be adopted in relations between railways themselves; rules to be adopted in relations between railways and consignors and consignees.

CASE-HARDENING

Chemical Energizers. More About Chemical Energizers, H. B. Knowlton. Forging & Heat Treating, vol. 8, no. 3, Mar. 1922, pp. 141–145, 2 figs. Action of chemical energizers during carburizing process; tests to prove relative efficiency of certain chemicals and methods of manufacture of compounds.

CAST IRON

Welding. The Dependability of Cast Iron Welding, G. O. Carter. Iron Age, vol. 109, no. 14, Apr. 6, 1922, pp. 928–930, 8 figs. Preheating and annealing essential; correct preparation of casting. Some results attained commercially. (Abstract.) Paper read before Cleveland section, Am. Welding Soc.

CASTING

Centrifugal. Producing Centrifugal Castings, H. Cole Estep. Iron Trade Rev., vol. 70, no. 13, Mar. 30, 1922, pp. 887–892, 19 figs. Process employed in England for making gray iron and nonferrous castings. Micrographs show effect of centrifugal force. See also Foundry, vol. 50, no. 6, Mar. 15, 1922, pp. 217–222, 19 figs.

Chilled. Inversed Chill Casting and Related Phenomena (Umgekehrter Hartguss und verwandte Erscheinungen), W. Heike. Stahl u. Eisen, vol. 42, no. 9, Mar. 2, 1922, pp. 325–332, 24 figs. Examples of occurrences. So-called black fracture. Inversed chill casting attributed to differences in pressure.

CASTINGS

Ingot Mold. How Ingot Mold Castings Are Made. Foundry, vol. 50, no. 6, Mar. 15, 1922, pp. 229–235, 11 figs. Practice at plant of Hanna Furnace Co. at Dover, Ohio, having capacity of 500 tons a day.

Internal-Combustion Engines. British Motor Castings Methods—I-VI, Ben Shaw and James Edgar. Foundry, vol. 50, nos. 1, 2, 3, 4, 5 and 6, Jan. 1, 15, Feb. 1, 15, Mar. 1 and 15, 1922, pp. 11–16, 57–62, 102–107, 149–152, 198–202 and 236–239, 129 figs. Jan. 1: Making of a wooden pattern of a water-jacketed cylinder block for an internal-combustion engine. Jan. 15: Preparation of mold; core problems; valve faces molded down; artificially bonded sand strengthened with rods and vented with wax. Feb. 1: Making of patterns and core-boxes for a typical crankcase casting. Feb. 15: Molding procedure dependent on whether machine is to be used or not. Patterns gated to cause aluminum to flow quietly. Mar. 1: Types of smaller castings for internal-combustion engines. Mar. 15: Methods for molding water-inlet, front-cover and oil-pan castings.

Looms. Loom Castings Tax Molder's Skill, H. R. Simonds. Foundry, vol. 50, no. 6, Mar. 15, 1922, pp. 223–224, 2 figs. Two core prints were attached to strengthen pattern as well as to form seat for longitudinal core at one side and pocket core at other end of intricate casting shown.

CENTRAL STATIONS

Modern Construction. Modern Tendencies in Central Station Construction (Les tendances modernes dans la construction des centrales), F. Scoumanne. Société Belge des Électriciens, vol. 35, Sept.-Oct. and Nov.-Dec. 1921, pp. 211-224 and 252-257, and vol. 36, Jan.-Feb. 1922, pp. 19-25, Sept.-Oct.: Discusses choice in the power of units, boilers and economizers, steam piping, coal and ash handling, automatic stoking, forced draft, etc. Nov.-Dec.: Deals with machinery room, including turbines, alternators, condensers. Jan.-Feb.: Switchboard arrangements, including bus-bars and distribution of current.

Montreal Street Railway. The Main Plant of the Montreal Street Railway, T. H. Fenner. Power House, vol. 15, no. 6, Mar. 20, 1922, pp. 15-21, 10 figs. Describes Hochelaga power house and its equipment, including 22 water-tube boilers, turbo generators, direct connected reciprocating units of large size, etc.

Superpower. The Superpower System. Am. Inst. Elec. Engrs., vol. 42, no. 4, Apr. 1922, pp. 287-297. Two articles dealing with essential elements of superpower plant. The first, by Henry Flood, Jr., deals with steam-electric plants proposed by system; and second, by L. E. Imlay, deals with hydroelectric plants, transmission system and superpower system as a whole.

CHAIN DRIVE

Inverted- and Roller-Tooth Type. Chain Drives, A. Bayliss. Eng. & Indus. Management, vol. 7, no. 10, Mar. 23, 1922, pp. 282-286, 3 figs. Practical notes concerning two main types, viz. (1) inverted tooth and (2) roller tooth type. Describes rocker-joint chain.

CHROME STEEL

Etching Medium for Tungsten and. New Etching Medium for Chromium and Tungsten Steels. Iron Age, vol. 109, no. 11, Mar. 23, 1922, p. 790, 1 fig. Special solution for detecting presence of carbides. Valuable as applied to high-speed steels. Translated from article by K. Daeves in Stahl u. Eisen, Sept. 8, 1921.

Nickel-Molybdenum and. Chrome and Nickel-Molybdenum Steels, C. N. Dawe. Iron Age, vol. 109, no. 11, Mar. 16, 1922, pp. 725-728, 2 figs. Comparison with other alloy steels for automobile use. Nickel molybdenum for case-hardening. (Abstract.) Paper presented at Soc. of Automotive Industries.

CHUCKING MACHINES

Automatic, for Railway Shops. An Improved Automatic Machine For Railway Shops. Ry. Gaz., vol. 36, no. 9, Mar. 3, 1922, pp. 351-352, 2 figs. Describes the Victor automatic chucking machine, made by W. G. Armstrong, Whitworth & Co., Ltd.

CLUTCHES

Friction. A New Friction Clutch of Radical Design Developed in France. Automotive Industries, vol. 46, no. 11, Mar. 16, 1922, pp. 609-610, 1 fig. Clutch is engaged by increasing foot pressure.

COAL HANDLING

Automatic. Automatic Coal and Ash Handling Plant, E. W. L. Nicol. Chem. Age (Lond.), vol. 6, no. 141, Feb. 25, 1922, pp. 234-236, 7 figs. Describes rotary truck tippler, the U link conveyor, and the "sandwich" system of feeding coke and coal.

COMBUSTION

Air Required for. Air Required for Combustion of Gases in Steel Plants, R. T. Haslam and A. F. Spiehler. Blast Furnace & Steel Plant, vol. 10, no. 3, Mar. 1922, pp. 174-175, 1 fig. Determination of amount of air required for combustion of various gases from B.t.u. content of gas.

Control Apparatus. Combustion Regulators (Verbrennungsregler). Elektrotechnischer Anzeiger, vol. 39, nos. 35 and 37, Mar. 2 and 7, 1922, pp. 268-270 and 293-294, 13 figs. Describes new governors patented by G. Ph. Haass, Obrigheim, Germany, consisting of undergrate-blast and swivel-damper regulators which are attached to furnace and boiler.

Modern Apparatus for Control of Cumbustion and Evaporation (Les appareils modernes destinés au controle de la combustion et de la vaporisation), Lucien Maugé. Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 133, no. 10, Dec. 1921, pp. 1237-1321, 84 figs. Describes apparatus at international exposition of Office Central de Chauffe Rationelle, including gas-analysis apparatus, thermometers and pyrometers, pressure gages, steam meters, etc.

CONDENSERS, STEAM

Low-Level Multi-Jet. New Condensers for an Old Turbine. Power, vol. 55, no. 13, Mar. 28, 1922, pp. 492-493. Baltimore plant makes unique application of low-level, multi-jet condensers.

CONVEYORS

Chemical Industry. Conveying Machinery in the Chemcial Industry, George Frederick Zimmer. Chem. Age (Lond.), vol. 6, no. 141, Feb. 25, 1922, pp. 230-233, 12 figs. Fundamental principles which should underlie economical employment of labor-saving devices; review of most suitable mechanical handling devices for specific purposes of chemical industry.

Portable. Handling with Portable Conveyors, E. J. Tournier. Gas Age-Rec., vol. 49, no. 11, Mar. 18, 1922, pp. 317-323, 18 figs. Discusses development of machinery for moving material, up to most recent designs of apparatus for the purpose.

Types. Conveying and Elevating Machinery, Gardner Mitchell. Instn. Mech. Engrs. Proc., vol. 2, no. 8, Dec. 1921, pp. 895-916 and (discussion) pp. 931-969, 16 figs. Deals with different types of conveyors and elevators.

COPPER ALLOYS

Cupro-Nickel, Cold Work in. The Internal Mechanism of Cold-Work and Recrystallization in Cupro-Nickel, Frank Adcock. Inst. of Metals Advance Paper for meeting Mar. 8, 1922, 20 pp., 45 figs. Results of experiments on commercial cupro-nickel (copper 80 per cent, nickel 20 per cent). See also Engineering, vol. 113, nos. 2932 and 2933, Mar. 10 and 17, 1922, pp. 305-308 and 340-342, 45 figs.

COST ACCOUNTING

Drop-Forge Plants. Forge Shop Burden and Estimating, George H. Koskey. Forging & Heat Treating, vol. 8, no. 3, Mar. 1922, pp. 136-140, 2 figs. Advocates machine-hour basis for burden system in place of flat burden rate over whole shop.

Paper-Mill Power Plant. Power Costs in Paper Mill Accounting, B. C. Gause. Paper, vol. 29, no. 26, Mar. 1, 1922, pp. 7-8. Classification of power expenses; apportionment of costs; overhead charges; elements of cost.

Predetermination of Costs. The Predetermination of Costs, J. McD. Cronin. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 221-224. Writer points out some of more glaring defects in commonly accepted methods of cost accounting and advantages derived from installation of modern methods. Notes on predetermination of burden factor, labor and material factor.

Sewage Works. Keeping Records and Accounts for a Small Sewage Works, Percy Lamb. Eng. & Contracting, vol. 57, no. 13, Mar. 29, 1922, pp. 294-295, 1 fig. Importance of accounting methods; meteorological records; method of recording results; working costs, fuel, repairs, etc. (Abstract.) From 1921 Proc. of Assn. of Mgrs. of Sewage Disposal Works.

COTTON GINS

Machinery. Cotton-Ginning Machinery, Solomon E. Gillespie. Mech. Eng., vol. 44, no. 4, Apr. 1922, pp. 231-236 and 242, 15 figs. Describes apparatus developed for mechanically handling raw seed cotton, removing lint therefrom, and forming it into shape suitable for delivery to baling press. Cotton-ginning process, and latest developments of various devices employed.

COTTON MILLS

Electric Drive. Electric Drive in Cotton Mills, George Wrigley. Gen. Elec. Rev., vol. 25, no. 2, Feb. 1922, pp. 102-110, 9 figs. Discusses electrical and individual drive and control of machines and explains operation performed by each type of machine.

COUPLINGS

Machining Large Flexible. Machining Large Flexible Couplings. Machy. (Lond.), vol. 19, no. 491, Feb. 23, 1922, pp. 632-634, 6 figs. Describes practice of Wm. Beardmore & Co., Ltd., Dalmuir, in machining large flexible couplings of a type extensively used in marine propulsion work.

CRANES

Electric Controllers. Electric Crane Controllers, J. F. Schnable. Am. Inst. Elec. Engrs. Jl., vol. 41, no. 4, Apr. 1922, pp. 313-319, 5 figs. Deals with problems concerning selection of ohmic values for resistors, and connection arrangements and resistance values involved in dynamic braking control of lowering loads.

Motor-Operated. Auxiliary Electrical Equipment for Motor-Operated Cranes, H. W. Eastwood. Am. Inst. Elec. Engrs., Jl. vol. 41, no. 4, Apr. 1922, pp. 319-328. Deals with brakes, overload protective panels and limit switches. Discusses various service requirements and describes several available types of magnet brakes and their particular fields of application.

Shipyard. Shipyard Cranes (Krananlagen für Schiffbau und Schiffsmaschinenbau), H. Kessner and Karl Bötticher. Schiffbau, vol. 23, no. 22-23, Mar. 1-8, 1922, pp. 645-669, 42 figs. Review of development in Germany in past 20 years in crane installations for construction of ships and ship machinery.

Shipyard Cableway Cranes (Hellingkabelkrane), Martin Bruckmann. Schiffbau, vol. 23, no. 22-23, Mar. 1-8, 1922, pp. 669-675, 10 figs. Describes Bleichert system and its installation in Hamburg shipyards. Economic advantages.

CRANKSHAFTS

Machining Automobile. Machining Automobile Crankshafts, Fred H. Colvin. Am. Mach., vol. 56, no. 14, Apr. 6, 1922, pp. 504-507, 11 figs. Approved methods of machining and balancing crankshafts. Data as to wheels for various grades of steels. Wheel speed and wear.

CUPOLAS

Center-Blast Tuyere. The Bottom or Center-Blast Cupola Tuyere, Geo. O. Vair. Can. Foundryman, vol. 13, no. 3, Mar. 1922, p. 25, 1 fig. Advantages and disadvantages compared with side-blast.

Flameless. Flameless Cupolas with Overgrate Blast (Flammenloser Kupolofen mit Oberwind). Zeit. für die gesamte Giessereipraxis, vol. 43, no. 5, Feb. 4, 1922, pp. 62-64. Suggestions for design and proper care of cupolas.

D

DIES

Forming and Assembling. Forming and Assembling Dies for Roll Cam, W. B. Greenleaf. Machy. (N. Y.), vol. 28, no. 8, Apr. 1922, pp. 618-619, 5 figs. Describes dies used in making parts for roll cam, including combination blanking and forming die; blanking, piercing, and flanging die; and assembling die.

DIESEL ENGINES

American Marine. Building American Diesel-Engines. Motorship, vol. 8, no. 4, Apr. 1922, pp. 259-263, 8 figs. Details of McIntosh & Seymour plant at Auburn, N. Y., where oil engines for 25 successful merchant ships have been turned out.

German Marine. Demonstration of the Deutsche Werke Engine. Motorship, vol. 8, no. 4, Apr. 1922, pp. 264-266, 10 figs. New 950-shaft hp. Diesel marine engine exhibited shortly after completing 7-day non-stop run. Four-cycle, crosshead, single-acting type, direct reversible.

1900-Hp. High-Speed. Investigation of a 1900-Hp. High-Speed Diesel Engine in a Cotton Spinning Plant in Augsburg (Germany) (Untersuchung einer 1900 PSe-Schnellläufer-Dieselmaschine in der Baumwollspinnerei am Stadtbach in Augsburg), H. Deinlein. Zeit. des Bayerischen Revisions-Vereins, vol. 26, no. 4, Feb. 28, 1922, pp. 25-27, 2 figs. Results of investigation carried out by Bavarian Revisions-Verein confirmed guaranteed efficiency of engine.

Nobel 1600-Hp. Tests on a 1600-Hp. Nobel Diesel Engine (Untersuchung eines 1600 PSe-Nobel-Dieselmotors), A. Rosburg. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 6, Feb. 11, 1922, pp. 137-139, 15 figs. Investigation of two-cycle Diesel engine described in same journal (no. 3, 1922) with regard to efficiency, fuel consumption, relation of indicated work to useful work, compressor, scavenging-pump and friction work at different speeds and load conditions. Test results.

DRILLING MACHINES

Multiple-Spindle Drill Heads. Multiple-spindle Drill Heads, George Hey. Machy. (Lond.), vol. 19, nos. 491 and 493, Feb. 23 and Mar. 9, 1922, pp. 621-627 and 702-705, 21 figs. Feb. 23: Discusses shortcomings of multiple-spindle drill heads, and describes design of multiple-spindle adjustable type for drilling of high tensile steels. Mar. 9: Fixed center type of drill head.

DROP FORGING

Practice. Drop-Forging Practice, J. H. Nelson. Soc. Automotive Engrs. Jl., vol. 10, no. 3, Mar. 1922, pp. 207-211. Discusses practice from standpoint of materials used; advocates more rigid inspection and testing of raw products to determine their fitness for use in making automatic forgings. Tabular data of chemical analyses and physical tests made on a 0.40 to 0.50 per cent carbon steel.

Perfecting. Perfecting a Drop Forging, J. H. G. Williams. Forging & Heat Treating, vol. 8, no. 3, Mar. 1922, pp. 152-155, 14 figs. Discusses various defects in drop forging and how to remedy them.

E

ELECTRIC DRIVE

Woolen Mills. Electric Driving in Scottish Woolen Mills, A. W. Stevenson. Electrician, vol. 88, no. 2284, Feb. 24, 1922, pp. 217-219, 4 figs. Discusses electric and steam drive, and describes the various processes to produce finished wool product.

ELECTRIC FURNACES

Basic-Hearth. Basic Hearth Electric Furnace for Cast Iron, George K. Elliott. Can. Foundryman, vol. 12, nos. 10 and 11, Oct. and Nov. 1921, pp. 41-42 and 44 and pp. 32-34. Advantages of electricity over other fuel, from the standpoint of clean, sound metal and uniform chemical analysis. Paper read before Instn. British Foundrymen.

Brass. Brass Melting in Electric Furnaces (Messingschmelzen im elektrischen Ofen) Herbert Hein. Metall-Technik, vol. 48, no. 2, Jan. 7, 1922, pp. 9-11, 4 figs. Describes Röchling-Rodenhauser system of two-phase induction furnace with auxiliary heating rings.

Fiat. The Fiat Electric Furnace (Il forno elettrico "Fiat"). Electtrotecnica, vol. 9, no. 4, Feb. 5, 1922, pp. 74-79, 16 figs. Describes furnace invented by Masera, of Acciaierie Fiat, which can be used advantageously for special steels in small quantities and for ordinary steel in large quantities.

Smelting. Smelting Iron Ore Electrically, R. Durrer. Iron Trade Rev., vol. 70, no. 12, Mar. 23, 1922, pp. 827-828, 1 fig. Comparison of operating conditions in standard and electric blast furnaces. Causes of hot and cold working. Relation of direct and indirect reduction in electric furnaces. Translated from Stahl u. Eisen, June 2, 1921.

Tool-Steel Melting. Electric Tool Steel Melting Practice, W. J. and S. Stuart Green. Three important factors: Acid or basic bottoms; liquid or cold charges and double or single voltage. Electric furnace in other roles.

ELECTRIC LOCOMOTIVES

Monophase. Monophase Locomotive for Swiss Federal Railway. Ry. Elec. Engr., vol. 13, no. 2, Feb. 1922, pp. 45-50, 8 figs. Detailed description of locomotive designed for both freight and passenger service. (Abstract.) From Bulletin of Brown, Boveri & Co.

Passenger, Chile. Electric Passenger Locomotives for Chilean State Rys. Ry. Rev., vol. 70, no. 9, Mar. 4, 1922, pp. 291-293, 2 figs. Describes the two types of locomotives for new electrified line between Valparaiso and Santiago.

Regeneration Characteristic Curves. Regeneration Characteristic Curves of Direct-Current Locomotives, C. A. Atwell. Elec. Jl., vol. 19, no. 3, Mar. 1922, pp. 113–116, 7 figs. Explains plotting of curves and regeneration characteristics.

ELECTRIC RAILWAYS

Braking, Regenerative. Regenerative Braking and Single-Phase Commutator Motors, B. Nordefeldt. Electrician, vol. 88, nos. 2287 and 2288, Mar. 17 and 24, 1922, pp. 312–314 and 340–341, 10 figs. Discusses regenerative braking on electric railways, especially problems arising in single-phase traction, and distinguishes between regenerative braking as a speed check on long down grades, and as required for bringing train to a standstill. Describes methods of single-phase that have been used or suggested and advantages and disadvantages of each. Abstract from Teknisk Tidskrift.

Development and Equipment. Electric Traction for Steam Railroads. Ry. Elec. Engr., vol. 13, no. 2, Feb. 1922, pp. 57–61, 1 fig. Tendencies of practice in United States. Limitations and advantages of equipment used.

Italy. Electric Traction (La questione della trazione elettrica), Alfredo Donati. Elettrotecnica, vol. 9, nos. 4 and 5, Feb. 5 and 15, 1922, pp. 84–91 and 104–112, 23 figs. Feb. 5: Discusses Italian developments since 1899 and gives details of three-phase system adopted for state railways. Feb. 15: Technical data of Valtellina, Monza-Lecco, Milano-Varese-Porto Ceresio, Torino-Modane and other lines, and technical and financial results of Italian electrification. Translated from Bul. de l'Association Internationale des Chemins de Fer, Sept. 1921, pp. 1199.

Mountain Districts. Electrical Operation in Mountain Districts, Frank Rusch. Ry. Age, vol. 72, no. 13, Apr. 1, 1922, pp. 833–834. Outline of operations on Chicago, Milwaukee & St. Paul. (Abstract.) From Milwaukee Employees' Mag., Mar. 1922.

Trackless Transportation vs. Trackless Transportation and the Electric Railway. Elec. Ry. Jl., vol. 59, no. 9, Mar. 4, 1922, pp. 355–362. Abstracts of papers read at Midyear Meeting of Am. Elec. Ry. Assn. How the Maryland Commission Acts, E. B. Whitman; City Service and British Conditions, C. D. Emmons; Auto Bus and Truck Good as Interurban Feeders, Harry Reid; and California Situation Regarding Rail and Trackless Transporation, Paul Shoup.

ELECTRIC WELDING

Boiler Tubes. Electrically Safe Ending Boiler Tubes, J. J. Sullivan. Ry. Elec. Engr., vol. 13, no. 3, Mar. 1922, pp. 102–103, 2 figs. Describes practice on Nashville, Chattanooga & St. Louis, at Nashville shops; cost of electric welding.

Steel Construction. Electric Welding Applied to Steel Construction, With Special Reference to Ships, A. T. Wall. Shipbldg. & Shipg. Rec., vol. 19, nos. 8 and 9, Feb. 23 and Mar. 2, 1922, pp. 239–242 and 271–272, 14 figs. Discusses various ways in which electric welding is being applied to ship construction and indicates further possibilities in this connection for steel structures; reasonable precautions to be taken in carrying out work. Paper read before Instn. Mech. Engrs.

ELECTRIC WELDING, ARC

Applications. Applications of Electric Arc Welding, E. Wahamaker. Ry. Elec. Engr., vol. 12, no. 10, Oct. 1921, pp. 376–382. Successful welding calls for three prime requisites: Proper equipment, proper materials, and necessary skill.

Cast Iron. Arc Welding of Cast Iron, A. R. Allard. Welding Engr., vol. 7, no. 3, Mar. 1922, pp. 19–22 and 40–41, 8 figs. Characteristics of cast iron which influence its weldability and general procedure for welding it. Paper read before Am. Welding Soc.

Cyc-Arc Process. The Cyc-Arc Process of Automatic Electric Welding, L. J. Steele and H. Martin. Instn. Elec. Engrs. Jl., vol. 60, no. 306, Feb. 1922, pp. 236–244. Discussion of paper which appeared in same journal in Jan. 1922 number, pp. 136–162.

Railway Shops. Arc Welding in Railway Shops, S. E. Mason. Elec. Ry. Jl., vol. 59, no. 11, Mar. 18, 1922, pp. 446–448, 5 figs. Repairs to rolling stock equipment can be made without removal from cars so that large savings in labor and material result.

Shipbuilding, Application to. On the Application of Electric Arc Welding to Two Vessels, M. Harmiishi. Am. Welding Soc. Jl., vol. 1, no. 2, Feb. 1922, pp. 31–41, 5 figs. Account of author's experience with arc welding in converting a steam trawler into an oil lighter, and work on a steel self-floating caisson for drydock in Japanese dockyard. (Abstract.) Paper read before Japanese Soc. of Shipbuilders.

EMPLOYEES, TRAINING OF

Extension Work in Factory. Taking University Training to the Factory, Paul M. Atkins. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 239–242. Describes plan consisting of university extension work in individual plant.

Manufacture. The Training of Workers in Manufacture, J. V. L. Morris. Am. Mach., vol. 56, no. 11, Mar. 16, 1922, pp. 400–402. Coöperative employment of engineering students. Length of shop period. Courses on technical subjects. Advanced shop and school instruction.

ENGINEERING

Human Activity. Engineering as a Human Activity, H. E. Riggs. Eng. News-Rec., vol. 86, no. 11, Mar. 16, 1922, p. 435. Deals with some of non-technical sides of engineering. Jobs and how to get them; fees and how to maintain them; etc. (Abstract.) Paper before Mech. Eng. Soc.

ENGINEERS

Code of Ethics. A Code of Ethics for Engineers. Min. & Metallurgy, no. 183, Mar. 1922, p. 46. Presents code and method of interpreting and administering it, recommended by Joint Committee on Code of Ethics.

Licensing. Advantages and Disadvantages of Licensing Engineers, B. B. Gottsberger. Min. & Metallurgy, no. 183, Mar. 1922, pp. 47–50. Arguments for and against licensing.

Practicing. How Practicing Engineers May Sell Their Services. Eng. News-Rec., vol. 88, no. 13, Mar. 30, 1922, pp. 523–524. Methods of securing clientele and increasing business. Abstract of two papers at Conference of Practising Engrs. under auspices of Am. Assn. Engrs.

ENGINEHOUSES

Cold Climate. Novel Engine Facilities for a Cold Climate. Ry. Mech. Engr., vol. 96, no. 3, Mar. 1922, pp. 163–164, 2 figs. Describes rectangular enginehouse with radial tracks and enclosed turntable of Canadian National Railways.

F

FACTORIES

Size and Efficiency. Considerations on Factory Size and Efficiency, Henry Baker. Engineer, vol. 133, no. 3455, Mar. 17, 1922, pp. 292–294, 2 figs. Writer concludes that factory just large enough to be well under control of one man probably represents most efficient size at present time. Future of large factory depends on overcoming difficulties of management.

FACTORY MANAGEMENT

See INDUSTRIAL MANAGEMENT.

FATIGUE

Industrial. Fatigue in Industry, Eugene Lyman Fisk. Am. J. Public Health, vol. 12, no. 3, Mar. 1922, pp. 212–217. Reviews literature discussing kinds of fatigue and how to measure fatigue.

FIREPROOFING

Wood and Textures. Protection Against Fire By Fireproofing Textures and Woods (La protection contre l'incendie par l'ignifugation des tissus et des bois), André Kling and Daniel Florentin. Génie Civil, vol. 80, nos. 8 and 9, Feb. 25 and Mar. 4, 1922, pp. 180–183 and 202–204, Feb. 25: Discusses especially fireproofing of stage decoration materials and describes two processes for the purpose. Mar. 4: Fireproofing of woods and methods employed; tests made to show their efficiency.

FLIGHT

Controls Locked. Airplane Flight With Locked Controls (Vol de l'avion à commandes bloquees), Maurac. Aerophile, vol. 30, no. 1–2, Jan. 1–15, 1921, pp. 9–11, 1 fig. Mathematical treatment of movement of center of gravity of a solid in a resisting medium.

Human Physical Sensations. The Human Machine in Aviation, Edward C. Schneider. Aerial Age, vol. 15, no. 4, Apr. 3, 1922, pp. 82–83, 86 and 95. Discusses human physical sensations in flying, including those caused by high altitude, insufficient oxygen, etc. Reprinted from Yale Rev.

Optical Delusions. Perception of Space and Location in Flight (Die Raumempfindung im Fluge), Friedrich Noltenius. Zeit. für Flugtechnik u. Motorluftschiffahrt, vol. 13, no. 3, Feb. 15, 1922, pp. 31–33. Discusses frequently occurring optical delusions of airmen in flight that earth or horizon is out of place.

Soaring. Engineless Flight (Le vol des avions sans moteur), Dorand. Aeronautique, vol. 4, no. 32, Jan. 1922, pp. 11–16, 4 figs. Discusses and calculates behavior of machines at various wind conditions and summarizes results.

FLOW OF GASES

Cylinders. The Flow of Gas Into a Cylinder, A. Johnson. Automobile Engr., vol. 12, no. 160, Feb. 1922, pp. 4143, 7 figs. Discusses flow of atmospheric air into cylinder of an internal-combustion engine, assuming that temperature of air does not alter. Works out calculations applicable to its flow.

Liquids and Gases. Determination from the Pressure Reduction in Pipes of Quantity of Gas and Liquid Flowing Therefrom (Bestimmung von strömenden Gas- und Flüssigkeitsmengen aus dem Druckabfall in Rohren), Max Jakob. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 8, Feb. 25, 1922, pp. 177–182. Simple calculation according to law of similarity of Reynolds and Blasius. The two constants of this law are newly determined by means of tests with air; tests with water show that with same constants, water quantities can be accurately calculated. Recommends use of smooth pipes instead of gasometers as standard measuring tool for nozzle calibrations.

FLUE GASES

Testing Apparatus. Apparatus for Testing Flue Gas, John B. C. Kershaw. Combustion, vol. 6, no. 3, Mar. 1922, pp. 125–128, 8 figs. Describes Duplex-Mono automatic, Foxboro-Heath CO_2, Hays automatic CO_2 and draft recorders.

The Unograph (Der "Unograph"), Kurt Müller. Archiv für Wärmewirtschaft, vol. 3, no. 2, Feb. 1922, p. 33, 1 fig. Describes apparatus for determination of carbonic acid which functions without use of absorption media.

FOREMEN

Teaching Ability, Developing. Building Up Teaching Ability in Foremen, D. J. MacDonald. Am. Mach., vol. 56, nos. 10 and 11, Mar. 9 and 16, 1922, pp. 369–361 and 406–408. Explains why average foreman is not a good teacher, and points out importance of planning teaching work, and what constitutes good teaching.

Training. As Foreman Is, So Is the Plant, C. R. Hook, E. A. Holbrook and Arthur Notman. Iron Trade Rev., vol. 70, no. 12, Mar. 23, 1922, pp. 820–822. Deals with training of foremen. Report of subcommittee on education of Am. Inst. Min. & Met. Engrs.

Foremanship Training, E. T. Teece. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 216–217. Notes on questions to be answered. Suggested outline of preliminary course.

FOUNDRIES

Cupolas. See CUPOLAS.

Desulphurization Process. The Walther Desulphurization Process (Das Walthersche Entschwefelungsverfahren). Zeit. für die gesamte Giessereipraxis, vol. 43, no. 8, Feb. 25, 1922, pp. 101–103. Account of tests carried out with this process at the A. Borsig foundry at Berlin-Tegel, demonstrating that it is possible, with comparatively simple means and without interference with operation or workers, to successfully combat the disagreeable sulphur enrichment. Abstract of paper by H. Scharlibbe and discussion before Assn. German Foundrymen.

Railway Iron and Steel. Control in a Railway Iron and Steel Foundry, G. N. Shaweross. Foundry Trade Jl., vol. 25, no. 281, Jan. 5, 1922, pp. 3–8, 7 figs. Discusses coöperation of chemist and molder, pre-war and post-war output, air compressors, cupolas, annealing and pyrometry, etc. Read before Cambridge Univ. Eng. Soc.

Space and Equipment, Utilization of. Volumetric Efficiency as a Measure of Foundry Costs, Douglas T. Sterling. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 201–205, 3 figs. Relations between floor space, flask volume and weight of castings.

FREIGHT HANDLING

Package. Organization and Modern Handling of Package Freight through Freight Houses, G. Marks. N. E. R. R. Club, Feb. 14, 1922, pp. 278–289 and (discussion) pp. 289–314. Author outlines facts and methods, based on results of personal observation and operation, in handling large volumes of freight in all sorts of places under varying conditions.

FUELS

See OIL FUELS; PULVERIZED COAL.

FURNACES, BOILER

German Bamag. The New Bamag Furnaces for High- and Low-Grade Fuels (Die neuen Bamagfeuerungen für gute und geringe Brennstoffe), H. Pradel. Wärme- u. Kälte-Technik, vol. 24, no. 5, Mar. 1, 1922, pp. 56–59, 6 figs. Describes new nozzle grate of the Berlin-Anhalt Machine Constr. Corp., and its application to their forced-draft horizontal grates, traveling grates and underfeed furnaces.

Semi-Producer-Type. The Bergmans Semi-Producer-Type Furnace (Bergmans-Halbgasfeuerung), H. Nettmann. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 6, Feb. 11, 1922, pp. 131–132, 2 figs. Details of furnace and basic principles on which design is based. Results of tests.

FURNACES, FORGING

Types. Discussion of Forge Furnaces, Charles Longenecker. Blast Furnace & Steel Plant, vol. 10, no. 3, Mar. 1922, pp. 194–196. Discusses soaking pits, regenerative and non-regenerative types, and furnaces of small hearth area, pointing out possibilities for saving and increased efficiency with various classes of fuel.

FURNACES, HEAT-TREATING

Lead Hardening. Lead Hardening Furnaces for Heating Hammers and Hatchets, G. T. Straub. Forging & Heat Treating, vol. 8, no. 3, Mar. 1922, pp. 160–161, 1 fig. Describes hardening furnaces used in Evansville Tool Works which have proved very satisfactory.

G

GAGES

Hand- and Machine-Lapped Surfaces of Precision. Hand- and Machine-Lapped Surfaces as Seen Through a Microscope. Machy. (N. Y.), vol. 28, no. 8, Apr. 1922, pp. 638–639, 6 figs. Includes examples of photomicrographs made by Pratt & Whitney Co., Hartford, Conn., in connection with study of characteristics of different surfaces, as obtained by various methods.

Machining Dial. Tooling Equipment and Methods Used in Making Dial Gages, Robert Mawson. Machy. (N. Y.), vol. 28, no. 8, Apr. 1922, pp. 627–630, 13 figs. Describes operations performed in Stickney & Randall plant, Waltham, Mass.

GAS ENGINES

Working Fluids, Properties of. Some Properties of the Working Fluid of Gas Engines, W. T. David. Engineering, vol. 113, no. 2932, Mar. 10, 1922, pp. 281–284, 2 figs. Notes on pressures developed on explosion; after-burning in gas engines; internal energy of working fluid; factors governing heat loss during explosion-expansion stroke. Results of experiments made by author.

GASES

Discharge Through Orifices or Nozzles. The Effect of Variable Specific Heat on the Discharge of

Gases Through Orifices or Nozzles, William J. Walker. Lond., Edinburgh, & Dublin Philosophical Mag. & Jl. Sci., vol. 43, no. 255, Mar. 1922, pp. 589–593. Discusses the question whether or not it is desirable to account for abnormal orifice or nozzle discharges by consideration of changes in value of γ, index in equation pv^{γ}=constant, for adiabatic changes of state.

GASOLINE

Anti-Knock Compounds for Aircraft. Effect of Doped Fuels on the Fuel System. Automotive Industries, vol. 46, no. 12, Mar. 23, 1922, p. 661, 1 fig. Use of anti-knock compounds in aircraft.

GEAR CUTTING

Machines. Commercial Gear-cutting Practice, Franklin D. Jones. Machy. (N. Y.), vol. 28, no. 6, Feb. 1922, pp. 437–446, 20 figs. Cutting of spur gears on automatic machines of formed-cutter type. See also Machy. (Lond.), vol. 19, no. 495, Mar. 23, 1922, pp. 749–757, 20 figs.

Shapers. Cutting Spur Gears on Gear Shapers. Machy. (N. Y.), vol. 28, no. 8, Apr. 1922, pp. 645–650, 14 figs. Use of machines operating with planing or shaping action and forming gear teeth by generating and formed-cutter processes.

GEARS

Automobile, Wear in. Wear on Various Automobile Gear Steels, E. R. Ross. Am. Mach., vol. 56, no. 14, Apr. 6, 1922, pp. 515–519, 6 figs. Results of tests showing various factors which affect wear in driving gears: A tooth-profile indicator.

Auto-Pitch. A New Form of Gear, W. Rees Darling. Machy. (Lond.), vol. 19, no. 492, Mar. 2, 1922, pp. 664–667, 17 figs. Describes auto-pitch gear obtained by roller flow, resulting from studies of requirements of a perfect gear. (Abstract.) Read before Instn. Engrs. & Shipbuilders in Scotland.

Hotchkiss-Taylor Tangent. The Hotchkiss-Taylor System of Gearing. Engineering, vol. 113, no. 2935, Mar. 31, 1922, p. 401, 10 figs. partly on p. 400. Describes system in which rack is arranged in plane tangential to cylinder. Basic gear form is a crown wheel, teeth of which are involute curves in plane normal to axis of crown wheel.

Spiral Bevel. The Spiral Bevel Gear. Machy. (Lond.), vol. 19, no. 492, Mar. 2, 1922, pp. 653–654, 2 figs. Comparison between arcs of action of spiral and helical teeth and straight teeth.

Tooth-Rolling Machine. Rolling the Teeth in Hot Gear Blanks, Frederick E. Walker, Jr. Am. Mach., vol. 56, no. 11, Mar. 16, 1922, pp. 409–412, 6 figs. Process eliminates cutting gear teeth. Rolling bevel gears in 15 seconds, and saving 20 to 40 per cent of metal.

Production by Rolling Process. Production of Gears by the Rolling Process. Can. Machy., vol. 27, no. 9, Mar. 2, 1922, pp. 46–47, 7 figs. Pressure required; forming of teeth; redressing die rolls; etc.

GLUES

Water-Resistant. Water Resistant Glues: Casein and Blood Albumin, Robert Herman Bogue. Chem. Age (N. Y.), vol. 30, no. 3, Mar. 1922, pp. 103–106. Manufacture of casein by lactic acid, acid coagulation grain-curd, and other methods; influence of method of manufacture; casein glue and cements; preparation of blood albumin glue.

GOVERNORS

Steam Haulage Engines. The Governing of Steam Haulage Engines (Die Fahrtregler der Dampfördermaschinen), H. Hoffmann. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 8, 9 and 10, Feb. 25, Mar. 4 and 11, 1922, pp. 173–177, 207–210 and 226–229, 29 figs. Uses and development of governors, and regulation of speed obtainable therewith. Astatic and static regulation. Nature and strength of static centrifugal governors; changing from one direction to the other; regulation of start. Examples of modern governors.

GRAIN ELEVATORS

Automatic Box-Car Unloader. Automatic Box-Car Unloading in Grain Elevators, C. D. Howe. Can. Ry. & Mar. World, no. 290, Apr. 1922, pp. 169–172, 6 figs. partly on p. 173. Describes automatic box-car unloader developed for use in reconstruction of Can. Nat. Rys. elevator at Port Arthur, Ont. which has storage capacity of over 8,500,000 bush. of grain.

Pneumatic. Discharge of Grain Cargoes in the Port of London by Pneumatic Elevators, R. E. Knight. Instn. Mech. Engrs. Proc., vol. 2, no. 8, Dec. 1921, pp. 917–931 and (discussion) pp. 931–969, 10 figs. Deals with pneumatic discharge of grain from ships.

GRINDING

Printing-Press Parts. Grinding Printing-Press Parts, B. K. Price. Abrasive Industry, vol. 3, no. 2, Feb. 1922, pp. 45–46, 2 figs. Cylinders and rolls are finished accurately on large grinders at plant of an eastern printing press manufacturer.

Shears. Grinding Shears in New England Plant, Herbert R. Simonds. Iron Trade Rev., vol. 70, no. 11, Mar. 16, 1922, pp. 754–756, 5 figs. Describes grinding problems involved in shear manufacture and practice at the Acme Shear Co., Bridgeport, Conn., producers of cast-steel shears and scissors complete from raw material to finished product.

GRINDING MACHINES

Centerless. Centerless Grinding Efficiency, H. J. Swanson. Abrasive Industry, vol. 3, no. 3, Mar. 1922, pp. 75–76, 1 fig. Rapid production is possible as wheel cuts continuously; results of practical tests are given and inspection methods are described.

Chilled Iron Rolls. Large Grinding Machine for Chilled Iron Rolls. Engineer, vol. 133, no. 3455, Mar. 17, 1922, p. 306, 2 figs. on p. 307. Describes heavy roll machine with capacity for work up to 36 in. diam. by 18 ft. between centers.

Oil Feed Control. Grinding Machine With Oil Feed Control. Can. Machy., vol. 27, no. 9, Mar. 2, 1922, p. 48, 2 figs. Design based upon principle of high traverse speeds.

Tool and Cutter. An Improved Tool and Cutter Grinder. Eng. Production, vol. 4, no. 75, Mar. 9, 1922, pp. 225–226, 5 figs. Details of improved pattern of universal machine by Alfred Herbert, Ltd., Coventry, one of distinctive features of which is provision made for wet grinding.

H

HAMMERS

Electric. The Electric Hammer, P. Trombetta. Am. Inst. Elec. Engrs., vol. 42, no. 4, Apr. 1922, pp. 297–305, 9 figs. Electric hammer has been studied and developed by writer to point where it seems to show superiority to present used hammers, in simplicity, safety, running expenses, cost of installation and upkeep, and in many cases in original cost. Development shown is of induction motor type.

HARDNESS

Scleroscope for Testing. Uses Scelroscope on Thin Sections, Fred S. Triton. Foundry, vol. 50, no. 6, Mar. 15, 1922, pp. 225–227, 2 figs. Samples a quarter-inch thick give accurate results when mounted by new methods. Low readings are obtained when samples are supported in ordinary ways. Paper presented before British Inst. of Metals.

HEALTH

Factory Dental Clinic. What a Dental Clinic Can Do in Your Factory, Linwood G. Grace. Factory, vol. 28, no. 4, Apr. 1922, pp. 405–407, 3 figs. Why dental clinic pays and how to operate one.

HEAT PUMPS

Evaporators and. Experiences on Evaporators with Heat Pumps (Erfahrungen an Eindampfanlagen mit Wärmepumpe), E. Wirth. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 7, Feb. 16, 1922, pp. 160–164, 13 figs. Reports on installations with evaporators for slowly boiling liquids and with vacuum evaporators for low-boiling temperatures show to what extent vapor compression has been realized after overcoming practical difficulties and as result of laboratory tests.

HEAT TRANSMISSION

Building Materials. A Study in Heat Transmission with Special Reference to Building Materials, F. C. Houghten. Am. Soc. Heating & Vent. Engrs. Jl., vol. 28, no. 2, Mar. 1922, pp. 151–172, 13 figs. Notes on theory of heat flow; methods of determining heat transmission. Discussion of research work on heat transmission through building and allied materials by various investigators. Work of research laboratory.

Conduction and Convection. Heat Transfer by Conduction and Convection, W. K. Lewis, W. H. McAdams and T. H. Frost. Am. Soc. Heating & Vent. Engrs. Jl., vol. 28, no. 2, Mar. 1922, pp. 97–106, 2 figs. Points out that mass velocity, viscosity and thermal conductivity are major factors in determining coefficient of heat transfer from gases or liquids to solids, and that, for accuracy, heat transfers must be calculated by use of film coefficients, one on each side of heating surface.

HEATING, ELECTRIC

Houses. Limits of Electric House Heating, E. A. Loew. Elec. World, vol. 79, no. 13, Apr. 1, 1922, pp. 623–625, 6 figs. Large-scale heating of residences, stores and other establishments in Tacoma shows limits within which electric heating may compete with other heat in mild climates. (Abstract.) University of Wash. Eng. Experiment Station, Bul. no. 15.

HEATING, STEAM

Central Stations. Mechanical Use of Power in Low-Pressure Steam to Improve the Position of Central Heating Stations (Utilization mécanique de l'énergie contenue dans la vapeur a très basse pression pour l'amélioration des installations de chauffage central), André Nessi. Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 133, no. 10, Dec. 1921, pp. 1322–1366, 31 figs. Use of steam for improving circulation of hot water and not air, for fans, pumps, etc.

HOISTS

Electric, Connections for. Hoisting-Machine Connections for Direct Current (Hebezeug-Schaltungen für Gleichstrom), L. Weiler. Siemens-Zeit., vol. 2, nos. 2 and 3, Feb. and Mar. 1922, pp. 76–81 and 108–114, 14 figs. Different types of connections by the Siemens-Schuckert Works; special connections, safety devices.

HYDRAULIC TURBINES

Efficiency Tests. Efficiency Tests of a New Turbine at the Boise Works (Note sur les essais de rendement d'une des nouvelles turbines de l'usine du Bois Noir), A. de Montmollin. Bul. Technique de la Suisse Romande, vol. 48, no. 4, Feb. 18, 1922, pp. 37–40, 2 figs. Results of tests of horizontal axis Francis turbines for Lausanne Electricity Works, showing nearly 90 per cent efficiency at full charge as against 81 per cent guaranteed.

Ejector, Moody. The Moody Ejector Turbine, S. Logan Kerr. Mech. Eng., vol. 44, no. 4, Apr. 1922, pp. 243–247, 15 figs. Particulars of a turbine for low-head installations which delivers rated horsepower at maximum efficiency when head is a maximum, and also maintains output when head is reduced at flood periods.

HYDROELECTRIC DEVELOPMENTS

Niagara Falls. Increasing Niagara Falls Power Development By 200,000 Hp., G. W. Morrison. Compressed Air Mag., vol. 27, no. 3, Mar. 1922, pp. 65–69, 12 figs. New project under construction by Niagara Falls Power Co., requiring driving of a 32-ft. tunnel, a distance of 4,500 ft.

HYDROELECTRIC PLANTS

Caribou, California. High Head Impulse Wheels at New Feather River Plant. Eng. News-Rec., vol. 88, no. 12, Mar. 23, 1922, pp. 472–477, 7 figs. Caribou hydro-electric plant in California has two 30,000-hp. impulse turbines under 1008-ft. head. Water is brought from headwater reservoir by tunnel, river and pipe. Includes article entitled General Features of Design of the Caribou Plant, by Albert A. Northrop; and article on transportation problem in plant construction.

Kern River, California. Hydroelectric Installation on the Kern River, Ely C. Hutchinson. Mech. Eng., vol. 44, no. 4, Apr. 1922, pp. 239–241, 7 figs. Two turbo-generators arranged for dual operation at either 50 or 60 cycles. Unique equipment for efficient use of water supply.

Modern Structures. The Construction of Modern Hydroelectric Plants (Die Bauausführung neuzeitlicher Wasserkraftanlagen), M. Enzweiler. Siemens-Zeit., vol. 2, no. 3, Mar. 1922, pp. 93–102, 27 figs. Deals with construction of dams, headwater canals, power stations, etc.

Sand Box. Design of Sand Box for Kern River Hydro-Electric Plant, H. L. Doolittle. Eng. News-Rec., vol. 88, no. 15, Apr. 13, 1922, pp. 616–617, 4 figs. Operation of high-head reaction turbines demands clear water. Test shows 400-ft. tank settles particles passing 200-mesh sieve.

Shawinigan Falls, Canada. Extension to Shawinigan Hydro-Electric Plant, Julian C. Smith. Can. Engr., vol. 42, no. 11, Mar. 14, 1922, pp. 299–306, 15 figs. New 41,000-hp. unit has world's largest steel casing and biggest valve ever built. Foundation slab is 12-ft. thick, 52-ft. space. Paper read before Eng. Inst. Can.

Test Code, A.S.M.E. Test Code for Hydraulic Power Plants and Their Equipment. Mech. Eng., vol. 44, no. 4, Apr. 1922, pp. 248–258, 13 figs. Preliminary draft of the sixth in series of 19 test codes being formulated by A.S.M.E. committee on power test codes.

I

ICE MANUFACTURE

Center-Freeze System. Ice Making by the Center Freeze System, A. G. Solomon. Power Plant Eng., vol. 26, no. 5, Mar. 1, 1922, pp. 279–281. Five-ton blocks are produced in 30 hr. from raw water.

Uniflow Engines, in. Ice-Making With the Uniflow Engine, Sterling H. Bunnell. Power, vol. 55, no. 13, Mar. 28, 1922, pp. 505–506, 1 fig. Comparison of electric-motor and steam-engine operation shows greater possibilities of economy for latter.

IMPACT TESTING

Mild Steel. New Tests With Repeated Impact (Nouvelles expériences de chocs repétes), Leon Guillet. Révue de Métallurgie, vol. 18, no. 12, Dec. 1921, pp. 755–757, 1 fig. Describes experiments with various mild steel test bars, showing especially effect of cold working.

INDICATORS

Steam-Engine, Diagram. Why Complete Compression Is Not Economical. Power, vol. 55, no. 13, Mar. 28, 1922, pp. 496–499, 11 figs. Discusses compression line on indicator diagram, showing that compression to inital pressure is not efficient. Describes graphical method of finding proper compression for any given cutoff.

INDUSTRIAL MANAGEMENT

Brass and Copper Industry. Management in the Brass and Copper Industry, James E. Morrison. Management Eng., vol. 2, nos. 1, 2, 3 and 4, Jan., Feb., Mar. and Apr. 1922, pp. 3–6, 4 figs.; 103–108, 8 figs.; 173–178, 6 figs. and 237–242, 4 figs. Account of author's experience during eight years in development of management methods in some of largest brass and copper mills in United States and Canada. Jan.: Possibilities in better utilization of existing resources. Feb.: Setting and using standards of accomplishment. Mar.: Problem of brass mill standards. Apr.: Planning for production in brass mill.

Overhead Distribution. Distributing Overhead to Allow Lower Sales Prices, Walter N. Polakov. Factory, vol. 28, no. 4, Apr. 1922, pp. 400–402, 4 figs. Outlines plan for decreasing costly item of idle machines and men until business comes back.

Production Control. Watching Production from the Office, A. W. Hinkel. Factory, vol. 28, no. 4, Apr. 1922, pp. 416–418, 5 figs. Describes planning department that actually controls production and makes it possible to guarantee date of completion.

Production Costs, Cutting. Cutting Production Costs by Combining Manufacturing Operations, C. B. Bartlett. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 198–200. Account of experience of large company which found that combining manufacturing operations helped materially to eliminate wasted production time.

Production Methods. Modern Production Methods. W. R. Basset. Am. Mach., vol. 56, no. 12, Mar. 23, 1922, pp. 443–445. Administrative methods. Advantages of functional organization; periodical reports save conference time.

Production Planning and Control. The Planning and Control of Production. R. O. Herford. Indus. Administration Jl., vol. 1, no. 9, Jan. 1922, pp. 259–261 (includes discussion). Discusses date, maximum output from a given plant, maximum output from limited capital, maximum output at minimum cost, as factors in control of production, etc.

Ratio Chart for Inventory Control. The Ratio Chart Applied to Inventory Control. Bert E. Holmes. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 243–245, 1 fig. Author shows facility with which ratio chart may be used for ascertaining rapidly and accurately various factors of inventory.

Routing. How to Study the Routing of Work. Edward H. Tingley. Management Eng., vol. 2, no. 4, Apr. 1922, pp. 209–214, 9 figs. Such analysis is said to be particularly helpful in older plants and those which have expanded rapidly.

Sales Records. Keeping Track of Sales and Distributors. A. H. Tuechter. Am. Mach., vol. 56, no. 15, Apr. 13, 1922, pp. 541–543, 9 figs. Cards and forms for recording sales and shipping data in shop and office. Records to show activities of agents.

Tool Crib Service. Stabilizing and Standardizing Tool Crib Service. James H. Delany. Indus. Management, vol. 63, no. 4, Apr. 1922, pp. 209–216, 2 figs. How to eliminate time and tool losses.

Tool-Division Organization. Organization of a Large Tool Division. H. P. Losely. Machy. (N. Y.), vol. 28, no. 8, Apr. 1922, pp. 632–637, 10 figs. Duties of various members and units of organization responsible for development of quantity production tools.

INDUSTRIAL ORGANIZATION

Knitting Mill. The Organization of Knitting Mills. Carle M. Bigelow. Management Eng., vol. 2, no. 4, Apr. 1922, pp. 221–226, 6 figs. Standardizing control of manufacturing.

INDUSTRIAL PLANTS

British. Famous British Works. Eng. Production, vol. 4, no. 75, Mar. 9, 1922, pp. 218–220, 6 figs. Layout of works of John I. Thornycroft & Co., Ltd. Basingstoke for manufacture of commercial motor vehicles, covering 18 acres.

INDUSTRIAL RELATIONS

Antagonism of Capital and Labor. The Inevitable Antagonism Between Employers and Employees. Management Eng., vol. 2, no. 4, Apr. 1922, pp. 233–236. Discussion of C. E. Knoeppel's article in March issue of same journal.

INJECTORS

Principle and Application. Practical Information About Injectors. Terrell Croft. Power, vol. 55, no. 12, Mar. 21, 1922, pp. 460–463, 11 figs. How different types work; advantages and disadvantages; applications; testing; selection; how to overcome operating troubles.

INTERNAL-COMBUSTION ENGINES

Castings for. Castings for Internal-Combustion Engines. Ben Shaw and James Edgar. Foundry Trade Jl., vol. 25, no. 290, Mar. 9, 1922, pp. 174–176, 28 figs. Considers pattern-shop and foundry work of smaller castings.

Combined Compressed-Air and. Possibilities of Combined Internal-Combustion and Compressed Air Engines. R. W. Robinson. Practical Engr., vol. 65, no. 1828, Mar. 9, 1922, pp. 148–149. Describes design of prime mover which will combine outstanding advantages of steam engine with those of internal-combustion engine and, as far as possible, eliminate disadvantages of both, to produce engine of greater thermal efficiency than present internal-combustion engine. From paper read before Inst. Mar. Engrs.

Efficiency. Efficiency of Internal-Combustion Engines (Rendement organique des moteurs à combustion interne). Andre Planiol. Comptes Rendus des Seances de l'Academie des Sciences, vol. 174, no. 10, Mar. 6, 1922, pp. 663–666. Discusses losses by friction as a criterion by which to judge mechanical quality of engine and describes new method of measuring friction losses.

Elastic. Elastic Internal-Combustion Engines (Elastische Verbrennungsmotoren). Aurel Persu. Motorwagen, vol. 25, no. 8, Mar. 20, 1922, pp. 153–158, 8 figs. Deals with increasing limit of elasticity of engines without changing volume of cylinder that is, for ordinary engines with constant stroke.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES, MARINE ENGINES, Still; OIL ENGINES.]

IRON AND STEEL

Packing for Export. Exporting Iron and Steel. V. G. Iden. Iron Trade Rev., vol. 70, no. 12, Mar. 23, 1922, pp. 823–826, 5 figs. Containers for certain classes of goods have been generally standardized for shipments intended for foreign markets. Deals with packing.

IRON CASTINGS

Gray. The Problem of Grey Iron Castings. H. J. Young. Foundry Trade Jl., vol. 24, nos. 279 and 280, Dec. 22 and 29, 1921, pp. 497–501 and 511–514, 19 figs. Composition of pig iron; possibilities of standard castings; turbine castings; duplexing; importance of graphite; test-bars; influence of phosphorus; sulphur-manganese balance versus silicon control; absence of standard composition in internal-combustion engines. Paper read before Inst. Min. Engrs.

J

JIGS

Standardization of Fixtures and. Standardization of Jig and Fixture Design. Machy. (N. Y.), vol. 28, no. 8, Apr. 1922, pp. 610–613, 5 figs. Discusses use of standardized parts, such as shoulder screws fixture keys, shoulder drill bushings, binder handles, etc.

L

LABORATORIES

Missouri School of Mines. Mining Laboratory of the Missouri School of Mines. C. R. Forbes. Min. & Sci. Press, vol. 124, no. 11, Mar. 18, 1922, pp. 359–360, 2 figs. Describes small experimental mine for purpose of supplementing classroom study of mining operations with laboratory where practical demonstrations might be given.

LATHES

Turret. The Herbert No. 11 Bar Turret Lathe. Machy. (Lond.), vol. 19, no. 491, Feb. 23, 1922, pp. 637–638, 3 figs. Describes lathe by Alfred Herbert, Ltd., Coventry, in which possibilities of danger, damage and wear have been reduced to a minimum.

LIGHTING

Committee Report. Illumination Items. Am. Inst. Elec. Engrs. Jl., vol. 41, no. 4, Apr. 1922, pp. 278–280, 3 figs. Report of Lighting and Illumination Committee on highway lighting, textile-mill lighting standards, elixit devices, and color temperature and its relation to quality of light.

Industrial Plants, Code for. Tentative Lighting Code. Textile World, vol. 41, no. 13, Apr. 1, 1922, pp. 79, 115 and 117. Rules and regulations made by Mass. Dept. of Labor and Industries for lighting industrial establishments.

LIQUID-MEASURING DEVICES

Tests. Testing of Liquid-Measuring Devices. Ralph W. Smith. U. S. Bur. of Standards, Weights and Measures, Miscellaneous Publications no. 48, 1922, pp. 64–72. Necessity for accuracy of mechanically operated liquid-measuring devices, and possibility of fraudulent use.

LOCOMOTIVE BOILERS

Seams, Calculating Efficiency of. Calculating the Efficiency of Boiler Seams. R. J. Finch. Ry. Mech. Engr., vol. 96, no. 4, Apr. 1922, pp. 193–196, 5 figs. Explains use of two tables which facilitate work and reduce chance for error; places where failure is likely to occur.

Tubes. Installing and Maintaining Charcoal Iron Locomotive Boiler Tubes. G. H. Woodroffe and C. E. Lester. Boiler Maker, vol. 22, no. 3, Mar. 1922, pp. 61–65, 20 figs. Makes recommendations regarding application of body tubes, superheater flues, and arch tubes. See also Ry. Mech. Engr., vol. 96, no. 4, Apr. 1922, pp. 221–225, 20 figs.

Welding. Expert Report on Locomotive Boiler Welding—Details of Approved Methods of Selecting Material and Perfecting Repairs. Ry. & Locomotive Eng., vol. 35, no. 3, Mar. 1922, pp. 62–64, 19 figs.

LOCOMOTIVES

British and American Design. British and American Locomotive Design and Practice. P. C. Dewhurst. Engineering, vol. 113, nos. 2934 and 2935, Mar. 24 and 31, 1922, pp. 373–377 and 405–408, 11 figs. Some comparative comments thereon from practical experience. Paper read before British Instn. Mech. Engrs.

British Works. The Works of the South Eastern and Chatham Rly. Co. Eng. Production, vol. 4, nos. 77 and 78, Mar. 23 and 30, 1922, pp. 271–275 and 298–302, 21 figs. Description of organization and shop practice in locomotive and car works.

Cab Signals. On the Question of Locomotive Cab Signals (France). Jules Verdeven. Inst. Ry. Assn. Bul., vol. 4, no. 3, Mar. 1922, pp. 537–552, 8 figs. Report on repeating and recording track signals on locomotive; different systems already used or tried; results obtained; recording running speed of locomotives.

Counterbalancing Reciprocating Masses. The Development of Counterbalancing in British Locomotive Practice. F. W. Brewer. Engineer, vol. 133, no. 3455, Mar. 17, 1922, pp. 298 and 300. History of development down to present-day practice.

Diesel-Engined. Possibilities of the Diesel Locomotive. Ry. Mech. Engr., vol. 96, no. 3, Mar. 1922, pp. 120–121. Editorial note. Disadvantages of Diesel engine for locomotive service.

Electric. See ELECTRIC LOCOMOTIVES.

Electric Camshaft Control. The English Electric Camshaft Control. English Elec. Jl., vol. 2, no. 1, Jan. 1922, pp. 27–35, 12 figs. Describes master controller for heavy locomotives and multiple-unit stock, designed to give reliability with lowest possible maintenance cost.

4-8-2 and 2-10-2 Types. New Mountain Type and Santa Fe Type Locomotives for the Manila Railroad. Ry. & Locomotive Eng., vol. 35, no. 3, Mar. 1922, pp. 55–56, 2 figs. Describes 4-8-2 type, with tractive effort of 28,600 lb., for passenger service, and 2-10-2 type, with tractive effort of 35,700 lb., for freight service.

Handling on Descending Grades. Handling Locomotives on Descending Grades. A. G. Newell. Ry. Mech. Engr., vol. 96, no. 3, Mar. 1922, pp. 132–135, 6 figs. Drifting and by-pass valves important; effect of reverse lever position and use of throttle.

New Russian 0-10-0 Type. Construction, Manufacture and Transport of the Locomotives for Russia Ordered From Nydqvist and Holm A. B. (Konstruktion, tillverkning och transport av de hos Nydqvist & Holm a.-b. beställda ryska lokomotiven). Bengt Sjölin. Teknisk Tidskrift (Utgiven av svenska teknologföreningen), vol. 52, no. 8, Feb. 25, 1922, pp. 119–131, 12 figs. Reviews development of Trollhättan work shops and describes new Russian 0-10-0-type locomotive building.

Tire-Roughing Mill. Tire-Roughing Mill. Engineering, vol. 113, no. 2934, Mar. 24, 1922, pp. 354–356, 4 figs. Describes powerful tire-roughing mill, which is capable of rough-rolling from slabbed blanks, ready for finishing mill, locomotive tires of largest diameter and can also produce broad rings up to 12 in. in width.

Trailer Wheels. Rolled Steel Trailer Wheels for Locomotives. Ry. Mech. Engr., vol. 96, no. 4, Apr. 1922, pp. 189–190, 3 figs. Also Ry. Age, Mar. 11, 1922, pp. 571–572, 3 figs. Method of manufacture of Edgewater Steel Co.

Valve Gear. Walschaert Valve Gear Variable Lead. Ry. Mech. Engr., vol. 96, no. 4, Apr. 1922, pp. 187–188, 4 figs. Modifications discusses secure ample lead while running combined with no lead when starting.

LUBRICANTS

Paraffin Series. Boundary Lubrication—The Paraffin Series. W. B. Hardy and Ida Doubleday. Royal Soc. Proc., vol. 100, no. A 707, Mar. 1, 1922, pp. 550–574, 5 figs. Results of experiments, and theory. Lubricating qualities of normal paraffins and their related acids and alcohols; influence of quantity of lubricant; solid lubricants; influence of chemical constitution.

Testing Apparatus. A Proposed Method for Solving Some Problems in Lubrication. William Stone. Commonwealth Engr., vol. 9, nos. 4 and 5, Nov. 1 and Dec. 1, 1921, pp. 115–122 and 139–149, 13 figs. Describes method of testing and construction of apparatus employed to determine conditions of formation and stability of lubricating film and effect of variations of viscosity in different parts of film due to varying temperatures. Results of tests carried out.

Viscosity and Friction. Viscosity and Friction. Winslow H. Herschel. Sci. Lubrication, vol. 2, no. 1, Jan. 1922, pp. 10–21, 2 figs. Viscosity effect in complete-film-lubrication regeme; viscosity estimation at one temperature from observed viscosity at another temperature; friction testing of bearing metals; transition point; oiliness of different lubricants; service tests; desirable features of oil-friction testing machines. Paper read before S.A.E.

LUBRICATING OILS

Automotive-Engine, Dilution of. The Dilution of Lubricating Oil in the Present Automotive Engine. William F. Parish. Sci. Lubrication, vol. 2, no. 1, Jan. 1922, pp. 5–7 and 21. Dilution through decomposition of oil; leakages of raw gasoline; leakages during compression stroke; extent to which dilution exists; results of dilution; wear; etc. Paper read before combined meeting of Am. Petroleum Inst., Soc. Automotive Engrs., and Nat. Automobile Chamber of Commerce.

Compounding. Compounding of Lubricating Oils. W. F. Osborne. Power, vol. 55, no. 14, Apr. 4, 1922, pp. 535–536. Points out that for steam-engine cylinders and marine-engine lubrication compounding is essential. On the other hand, a pure mineral oil should be used where there is any danger of water causing emulsion.

Emulsions. The Cause of Emulsions in Lubricating Oils. W. F. Osborne. Power, vol. 55, no. 13, Mar. 28, 1922, pp. 502–503. Notes on separation of water and oil; impurities in oil; effect of compounding.

Pour Test. The Meaning of Cloud and Pour Points in Lubricating Oil. W. F. Osborne. Power, vol. 55, no. 12, Mar. 21, 1922, pp. 458–459, 2 figs. Describes method of making pour test.

Steam Cylinders. Compounded Cylinder Oil for Superheated Steam Conditions. Lubrication, vol. 8, no. 1, Jan. 1922, p. 9. Recommends use of medium-heavy viscosity cylinder oil, having about 4 or 5 per cent of animal oil.

Steam-Turbine. Keeping Steam Turbine Lubricating Oil in Good Condition. Charles H. Bromley. Sci. Lubrication, vol. 1, no. 12, Dec. 1921, pp. 5–11, 7 figs. Lubrication trend in turbine practice; turbine-oil circulating systems; formation of emulsion and sludge; acidity; continuous by-pass system; requirements of efficient oil filter for purifying steam turbine oil; etc. Reprinted from Gen. Elec. Rev.

Substitutes. Lubricants and Their Substitutes (Ueber Schmiermittel und deren Ersatzstoffe). Bruno Simmersbach. Wärme- u. Kälte-Technik, vol. 24, no. 5, Mar. 1, 1922, pp. 53–56. Experience in Germany with substitute oils.

LUBRICATION

Lubricants and. Lubrication and Lubricants. Sibley Jl. of Eng., vol. 36, no. 2, Feb. 1922, pp. 18–29 and 37, 7 figs. Discusses loss of friction, viscosity of lubricants, laws of lubrication, etc.

Theory. Theory of Lubrication. William F. Parish. Sci. Lubrication, vol. 1, no. 11, Nov. 1921, pp. 15–19. Discusses the two functions of a lubricant, keeping

surfaces apart, and conveying heat from surfaces that is caused by friction.

M

MACHINE SHOPS

High-Speed Production. Examples of Modern High Speed Production. H. A. Wilson. Can. Machy., vol. 27, no. 7, Feb. 16, 1922, pp. 27–30, 11 figs. Methods adopted at Ford motor plant.

Modern Design. An Eastern Shop of Modern Design. C. E. Clewell. Am. Mach., vol. 56, nos. 14 and 56, Apr. 6 and 13, 1922, pp. 508–511 and 558–559, 7 figs. Machine-tool plant of Gould & Eberhard, Irvington, N. J., has saw-tooth roof and reinforced-concrete frame. Mercury-vapor lamps for shop. Railroad and power facilities. Crane service and sanitary arrangements.

MACHINE TOOLS

Bearings, Adjustments of. The Adjustment of Machine Tool Bearings. Fred Horner. Machinery (Lond.), vol. 19, no. 482 and 483, Dec. 22 and 29, 1921, pp. 342–347, 385–387, 53 figs. Discusses divided, solid, and tapered bearings, and gives a number of examples of their adjustments; contraction of parallel bushings; capped bearings; end adjustments.

Economical. Economical Machine Tools (Wirtschaftliche Werkzeugmaschinen). H. Vossmann. Betrieb, vol. 4, no. 11, Mar. 4, 1922, pp. 345–349, 8 figs. Main features of a single-disc high-speed lathe and a new turret lathe. Results of tests on a four-spindle automatic machine. Relations between cutting speed and width of cutting and between efficiency and sharpness of tools. A logarithmic alignment chart is presented, with help of which, number of pieces machined per hr. on automatic machines, and working time for given length on lathes can be determined.

Progress. Machine Tool Progress. Engineering, vol. 113, no. 2933, Mar. 17, 1922, pp. 424–426, 9 figs. Describes machining methods and appliances developed in recent years at works of Alfred Herbert, Ltd., Coventry, England.

MALLEABLE IRON

Manufacture. Progress in Manufacture of Malleable Iron. Enrique Touxeda. Can. Foundryman, vol. 13, no. 3, Mar. 1922, pp. 32–34. Air-furnace thermal efficiency; proportioning air supply; use of waste-heat boilers; design of double-hearth furnace; use of coke-oven gas; etc.

MARINE ENGINES

Still. The Still Engine for Marine Propulsion. Archibald Rennie. Engineering, vol. 113, nos. 2931 and 2932, Mar. 3, and 10, 1922, pp. 275–278, 14 figs. partly on supp. plate and pp. 309–312, 8 figs. Also Mar. Engr. & Naval Architect, Mar. 1922, pp. 107–110, 4 figs. (Abstract.) Discusses engine of single-piston type which works on its combustion (or top) side upon two-stroke port scavenging principle, and employs airless (solid) injection for fuel oil; on its steam (or bottom) side it operates upon single-acting principle.

MEASURING INSTRUMENTS

Accuracy. The Accuracy of Measuring Instruments (Genauigkeiten der Messzeuge). R. P. Schröder. Betrieb, vol. 4, no. 9, Feb. 11, 1922, pp. 269–274. Notes on gage blocks, initial comparative, trial and working gages. Measurement of workpieces.

Optical Equipment. Optical Auxiliary Equipment for Measuring Instruments (Optische Hilfsmittel an Messgeräten). Walter Block. Betrieb, vol. 4, no. 9, Feb. 11, 1922, pp. 285–289, 6 figs. Discusses optical media for measuring instruments of all kinds, but especially those used in machine construction, for purpose of manipulating them with greater ease and accuracy.

METALS

Grain Growth and Recrystallization. Grain Growth and Recrystallization in Metals. Zay Jeffries and R. S. Archer. Chem. & Met. Eng., vol. 26, nos. 8, 9 and 10, Feb. 22, Mar. 1 and 8, 1922, pp. 343–345, 402–410 and 449–457, 39 figs. Feb. 22: Technical definition of recrystallization, and list of recrystallization temperatures for common metals. Methods for measuring grain size, shape and volume. Mar. 1: Effect of time and temperature of heating, degree of cold-work, original grain size and obstructing impurities on grain growth of metals and solid solution alloys. Mar. 8: Possible causes of grain growth; recrystallization is grain growth of fragmented crystals; germination; formation of nuclei.

Mechanical Properties of. Variation of Mechanical Properties in Metals and Alloys at Low Temperatures (Sur la variation des propriétés mécaniques des métaux et alliages aux basses températures). Léon Guillet and Jean Cournot. Comptes Rendus des Séances de l'Académie des Sciences, vol. 174, no. 6, Feb. 6, 1922, pp. 384–386. Experiments with a number of metals; table of Brinell hardness and resiliency of these at +20 deg., −20 deg., −80 deg. and liquid-air temperatures.

Strength and Fatigue. Calculation of a Non-Circular Cylindrical Envelope (Méthode générale de calcul des enveloppes cylindriques a section non circulaire). P. Cayere. Houille Blanche, vol. 20, no. 59–60, Nov.-Dec. 1921, pp. 213–216, 5 figs. Discusses interior pressure, fatigue of metals, etc.

Tensile Strength of Plastic. Tensile Strength (Verfestigung und Zugfestigkeit). Friedrich Körber. Stahl u. Eisen, vol. 42, no. 10, Mar. 9, 1922, pp. 365–370, 8 figs. The mechanics of tensile test of plastic metals. Notes on calculation of tensile strength from curve of true stresses. Theory that slip and rotation of crystal elements takes place is confirmed.

METEOROLOGY

Wind, Velocity of. Variation of Velocity of Wind With Altitude (La variation de la vitesse du vent avec l'altitude). Ch. Maurain. Révue Générale des Sciences, vol. 33, no. 3, Feb. 15, 1922, pp. 76–80, 5 figs. Discusses results obtained by means of recording balloons and gives comparative curves.

MICROMETERS

Lever Gages and. Accuracy Requirements of Micrometers and Lever Gages (Genauigkeitsanspruche an Mikrometer und Fuhlhebel). G. Berndt. Betrieb, vol. 4, no. 9, Feb. 11, 1922, pp. 280–284. Relation between measuring and reading accuracy of screw micrometers. Suggestions for increasing accuracy of lever gages.

MILLING MACHINES

Universal. Economical Use of High-Power Universal Milling Machines (Wirtschaftliche Verwendung von Hochleistungs-Universal-Fräsmaschine). H. Pohlmann. Betrieb, vol. 4, no. 11, Mar. 4, 1922, pp. 360–363, 9 figs. Describes machine constructed by Mammutwerke, Nuremberg, Germany.

Vertical. The "Relmil" Vertical Milling Attachment. Machinery (Lond.), vol. 19, no. 493, Mar. 9, 1922, p. 699, 2 figs. Distinguishing feature is that it does not clamp or fix on lathe saddle. Is secured to back of lathe bed and also to chip tray by means of two substantial cast-iron brackets.

MOLDING

Plastic and Powdered Substances. Moulding Plastic and Powdered Substances (including Casting Substances other than Metals and Presses, Mechanical). Abridgments of Specifications, class 87(ii), 1922, 379 pp. Patents for inventions for period 1909–15.

MOLDING METHODS

Boxes. A New System in Molding-Boxes. Mech. World, vol. 71, no. 1835, Mar. 3, 1922, p. 161. Describes box having separate ends and sides, secured by a pin and two wedges, of opposed bevel, at each joint. System has proved very satisfactory in sizes from 16 in. sq. to 80 in. sq. Translated from Giesserei-Zeitung.

MONEL METAL

Water Works, Suitability for. Monel Metal and Its Suitability for Water-Works Use. H. S. Arnold. N. E. Water Works Assn. Jl., vol. 36, no. 1, Mar. 1922, pp. 86–93 and (discussion) pp. 93–94. Describes source of supply and method of manufacture. Physical properties and uses.

MOTOR-TRUCK TRANSPORTATION

Graphical Control. A Graphical Control of Motor Truck Transportation. Howell B. May. Factory, vol. 28, no. 4, Apr. 1922, pp. 410–412, 3 figs. Describes graphical planning and recording system which it is claimed, makes it possible to realize greatest number of productive minutes out of total 480 that truck is out of garage.

MOTOR TRUCKS

German Types. Motor Trucks with Special Regard to Types Exhibited at the German Automobile Show (Der Lastkraftwagen und seine vielseitige Verwendung unter besonderer Berücksichtigung der auf der D.A.A. ausgestellt gewesenen Bauarten). Karl Redtmann. Fördertechnik u. Frachtverkehr, vol. 15, nos. 1 and 2, Jan. 6 and 20, 1922, pp. 8–13 and 27–33, 39 figs. Details of various German types.

Tipping Gear. Gravity-Type Tipping Gear for Motor Wagons. Engineering, vol. 113, no. 2934, Mar. 24, 1922, p. 358, 3 figs. With described gear center of gravity of load during tipping operation moves along a straight line, with slight downward slope towards rear end of wagon.

O

OIL ENGINES

Combustion. Combustion Process in Oil Engines (Der Verbrennungsvorgang im Oelmotor). Constantin Redzich. Wärme- u. Kälte-Technik, vol. 24, no. 2, Jan. 15, 1922, pp. 17–18. Review and discussion of scientific investigations.

Doxford. Doxford's Engine and Boiler-Oil. J. L. Chaloner. Motorship, vol. 7, no. 3, Mar. 1922, pp. 187–188. Improvements made in Doxford engine and economies effected by use of boiler-oil.

Fishing Boats. Engines for Fishing Boats (Les moteurs des bateaux de pêche). Edmond Marcotte. Technique Moderne, vol. 13, nos. 11 and 12, Nov. and Dec. 1921, pp. 449–457 and 518–524, and vol. 14, no. 1, Jan. 1922, pp. 21–26, 33 figs. Nov.: Discusses those of French manufacture, including kerosene and semi-Diesel engines; their operation and control. Dec.: The Tuxham-Delaunay-Belleville engine, and the Atlas Semi-Diesel. Jan.: The Bellenger and Renault Semi-Diesels, and the Chalessière Diesel engines.

Hot-Bulb Marine. New Hot-Bulb Marine Engines of the German General Electric Co. (Neue AEG-Glühkopf-Schiffsmotoren). Motor u. Auto (formerly Oel- u. Gasmaschine and Kraftwagen), vol. 19, no. 3, Feb. 15, 1922, pp. 33–36, 2 figs. Development and present status of construction.

OIL FUELS

Boilers for. Liquid Fuel For Steam Boilers (L'Emploi des combustibles liquides pour le chauffage des foyers industriels et particulièrement des chaudières à vapeur). Louis Cauchois. Bul. des Associations Françaises de Propriétaires d'Appareils à Vapeur, no. 2, Oct. 1920, pp. 37–68, 6 figs. Properties of combustible liquids and precautions necessary in handling, including petroleum and its derivations, shale oil, alcohol, etc. Burners of various types.

Heavy, in Carburetor. The Use of Heavy Oil Fuels in Carburetors (Zur Frage der Verwendung schwerer Brennstoffe in der Vergasermaschine). J. Plünzke. Motorwagen, vol. 25, no. 7, Mar. 10, 1922, pp. 125–127, 5 figs. Determination of boiling curve for two fuels, naphthalene and anthracene, during suction and compression.

Injection and Combustion. Injection and Combustion of Fuel-Oil—VII. C. J. Hawkes. Motorship, vol. 7, no. 3, Mar. 1922, pp. 195–196, 1 fig. Experiments with solid injection and air blast in marine Diesel engines. (Continuation of serial.)

Internal-Combustion-Engine. Internal-Combustion Engine Fuels. C. A. Norman. Soc. Automotive Engrs. Jl., vol. 10, no. 3, Mar. 1922, pp. 187–192 and (discussion) 192 and 203. Discusses use of kerosene and gasoline, and substitute fuels, including shale oils.

Steam Power. Fuel Oil For Steam Power. A. D. White. Combustion, vol. 6, no. 4, Apr. 1922, pp. 175–176, 1 fig. Advantages of fuel oil over coal; conditions for efficiency; controlling steam supply; preheating of oil.

OPEN-HEARTH FURNACES

Design. Design of Open Hearth Furnaces. A. D. Williams. Iron Age, vol. 109, nos. 15 and 17, Mar. 16 and 30, 1922, pp. 717–719, 1 fig. and 853–855, 2 figs. Mar. 16: Regenerator computations for volume and weight of checker work required. Temperature changes based on time reversals. Mar. 30: Regenerator and flue calculations for frictional resistance to passage of air and gases. Summation of losses.

Fluorspar, Use of. Fluorspar in Open-Hearth Practice. Iron Age, vol. 109, no. 11, Mar. 23, 1922, pp. 783–784. Effective agent in removing sulphur from steel. Action on slag and furnace lining. Old ideas altered. Translated from article by S. Schleicher in Stahl u. Eisen, Mar. 17, 1921.

German. Arrangement of Open Hearths in Germany. Hubert Hermanns. Blast Furnace & Steel Plant, vol. 10, no. 3, Mar. 1922, pp. 192–194, 3 figs. Steelmakers of Germany have not adopted water-cooled parts, but use detachable posts; arrangement of gas and air chambers is of special interest.

OXY-ACETYLENE CUTTING

Cast Iron. Cutting Cast Iron With the Oxyacetylene Torch. Alfred S. Kinsey. Stevens Indicator, vol. 38, no. 4, Oct. 1921, pp. 287–296, 5 figs. Reviews progress made with oxyacetylene torch; how to cut cast iron; effects of oxyacetylene cutting on cast iron; advantages; theory of cutting of metals by gas.

OXY-ACETYLENE WELDING

Cutting and. Modern Iron Welding and Cutting Devices with Dissolved Acetylene and Oxygen (Neuzeitliche Eisen-Schweiss- und -Schneideinrichtungen mit gelostem Acetylen und Sauerstoff). H. Kropf. Metall-Technik, vol. 48, no. 1, Jan. 1, 1922, pp. 3–4. Describes installations for workshops which are entirely fire- and explosion-proof, and can be used for various welding and cutting operations with great amount of economy and efficiency.

Instruction Sheet. Proposals for New Factory Instruction Sheets (Entwurfe neuer Betriebsblatter). Betrieb, vol. 3, no. 11, Mar. 4, 1922, pp. 39–40. Proposal of Works Dept of German Federation of Technical and Scientific Societies for care and manipulation of gas-welding equipment.

Rods for. Choosing Rods for Welding Work. J. R. Dawson. Iron Trade Rev., vol. 70 no. 15, Apr. 13, 1922, pp. 1033–1036 and 1043, 10 figs. Selection of welding rod for oxy-acetylene process depends on service requirements of finished weld. Inspection of rods and tests of welds aid in determining choice of materials. (Abstract.) Paper delivered before Int. Acetylene Assn.

Safety in. Safety Engineering as Applied to Oxy-Acetylene Cutting and Welding Apparatus. F. J. Napolitan. Am. Welding Soc. Jl., vol. 1, no. 2, Feb. 1922, pp. 13–30, 3 figs. Writer emphasizes safety of modern acetylene generators. Discusses acetylene and its generation; explosive mixtures; portable acetylene cylinders and oxygen cylinders; high-pressure gages; torches and tips; flashbacks; etc.

P

PAPER MANUFACTURE

Tar Paper. Tar Paper (Le carton bitumé). J. Tricard. Arts et Métiers, vol. 74, no. 10, July 1921, pp. 216–218, 7 figs. Discusses manufacture which has been developed during war, to supply quick and cheap protection in inclement weather.

PARACHUTES

Calthrop "H" Type. The Calthrop "H" Type Parachute and Frontal Suspension Harness. Flight, vol. 14, no. 12, Mar. 23, 1922, pp. 176–177, 5 figs. Describes latest model, "Guardian Angel" and its method of operation.

PLANERS

Open-Side. A Large Open-side Planing Machine. C. S. Pettit. Machinery (Lond.), vol. 19, no. 493,

Mar. 9, 1922, pp. 689-690, 1 fig. Describes machine in which peak load is of negative character, produced by use of fly-wheels in special positions which absorb reversal effort and actually take load off motor for the time being.

PLASTIC MATERIALS

Plastic Wood. Plastic Wood, Engineer, vol. 133, no. 3453, Mar. 3, 1922, pp. 230-231. Describes material like soft wood, but without grain having cellulose nitrate as a base, chief raw material being cotton. It has consistency of dough used in pastry making and can be molded into any conceivable form; it can be used for patching up patterns and rounding off fillets and in molding process for making small articles. Process of manufacture.

PLATES

Steel, Manufacture and Properties of. Manufacture and Properties of Steel Plates Containing Zirconium and Other Elements, George K. Burgess and Raymond W. Woodward. U. S. Bur. of Standards Technologic Papers, no. 207, Feb. 2, 1922, pp. 123-176, 16 figs. Describes manufacture and certain physical properties obtained from steel plates produced from about 193 heats of steel containing in various combinations following principal variable elements: Carbon, silicon, nickel, aluminum, titanium, zirconium, cerium, boron, copper, cobalt, uranium, molybdenum, chromium and tungsten.

POWER PLANTS

British Practice. Notes on British Power Plant Practice, C. H. S. Tupholme. Power Plant Eng., vol. 26, no. 6, Mar. 15, 1922, pp. 315-319. Efforts directed by engineers toward securing higher fuel economy, due to continued high prices of fuel.

Design. Developments in Power Station Design. Engineer, vol. 133, no. 3455, Mar. 17, 1922, pp. 290-292, 10 figs. partly on p. 302. Describes cooling towers of Powell Duffryn Steam Coal Co. built by Davenport Engineering Co., each designed to reduce temperature of 216,000 gal. of water per hr. from 100 deg. Fahr. under average atmospheric conditions; turbine-driven feed pump; coal and ash-handling plant, etc.

Rubber-Tire Factory. A Modern Power Plant in the Rubber-Tire Industry. Power, vol. 55, no. 12, Mar. 21, 1922, pp. 448-454, 15 figs. Details of coal-handling equipment, water-tube boilers, superheaters, steam turbines, air compressors and hydraulic pumps of the Cumberland (Md.) Plant of Kelly-Springfield Tire Co.

POWER TRANSMISSION

Oil Variable Gear. Power Transmission by Oil (Elauic Gear), H. S. Hele-Shaw. Instn. Mech. Engrs. Proc., no. 7, 1921, pp. 843-873, 16 figs. Author discusses power transmission when it is accompanied with its transformation, and where oil is employed as working agent. Design and applications of oil variable gear, or elaulic gear.

PRESSES

Forging, Steam-Hydraulic. Steam-Hydraulic Forging Presses (Les presses vapo-hydrauliques a forger). Outillage, vol. 249, no. 9, Mar. 4, 1922, pp. 271-274, 6 figs. Describes hydraulic presses in which high-water pressure is produced by steam compressor.

Safety Devices. Making a Punch Press Department Safe, C. B. Auel. Am. Mach., vol. 56, no. 14, Apr. 6, 1922, pp. 501-503, 9 figs. How manufacturing company has greatly reduced accidents. Methods and devices that helped make for safety.

PRESSURE VESSELS

Mechanically Welded. The Strength of Mechanically Welded Pressure Containers, R. J. Roark. Mech. Eng., vol. 44, no. 4, Apr. 1922, pp. 225-230, 18 figs. Describes pressure tests made on electrically welded, gas-welded, and riveted pressure containers, and tension and shear tests made on specimens of welded-metal, carried out for purpose of demonstrating strength and uniformity of construction in which electric weld is employed.

PRESSWORK

Tools for Aluminum Ware. Press Tools for Aluminum Ware, Frank A. Stanley. Am. Mach., vol. 56, no. 12, Mar. 23, 1922, pp. 437-438, 5 figs. Press tools for blanking, bending and perforating; how body is drawn; spouts attached by use of welding torch.

PRODUCER GAS

Cleaning Without Washing. Cleaning Producer Gas Without Washing, James H. Matheson. Iron Age, vol. 109, no. 14, Apr. 6, 1922, pp. 916-917, 4 figs. Gas equalizer and soot collector developed to treat gas from bituminous coal.

Furnace Work, Producer Gas for Furnace Work. Engineering, vol. 113, no. 2934, Mar. 24, 1922, pp. 347-351, 34 figs. partly on supp. plate. Describes low-temperature rotary carbonization plant devised by Harold Nielsen, consisting essentially of combination of ordinary producer with low-temperature carbonizing retort, in which partial distillation of raw coal is effected by sensible heat of producer gas. Designed to improve efficiency of manufacture of producer gas, and permit recovery of valuable by-products.

PULVERIZED COAL

Systems of Burning. Burning Pulverized Fuel—V, F. P. Coffin. Combustion, vol. 6, no. 4, Apr. 1922, pp. 181-184, 2 figs. Discusses conditions of efficient combustion, tube slag, effect of furnace temperature on ash, baffling of horizontal water-tube boilers, and describes some recent installations. Excerpts from author's contribution on "The Utilization of Coal on a Multiple-Product Basis" to Bacon and Hamor's "American Fuels."

PUMPING PLANTS

Diesel-Driven. Diesel-Driven Pumping Plant for Trinidad. Engineer, vol. 133, no. 3453, Mar. 3, 1922, p. 248, 3 figs. partly on p. 242. Describes treble-ram pump for Trinidad, with capacity of 76,000 gal. per hr. when running at 44 r.p.m. and with head of 350 ft. Pump is driven by means of 200-hp. Diesel engine of four-cylinder, four-cycle pattern.

PUMPS

High-Lift Turbine. High Lift Turbine Pumps A. M. Attack. So. African Instn. Engrs. Jl., vol. 20, no. 7, Feb. 1922, pp. 130-145 and (discussion) 145-146, 19 figs. Discusses some of the more important features upon which a successful design will depend, including multi-stage and centrifugal pumps, pumps in series, axial thrust, pumps driven by synchronous motors, sinking pumps, impellers, diffuser, etc.

Jets, Impact Losses of. Impact Losses of Jets, J. B. Burnell. Engineering, vol. 113, no. 2935, Mar. 31, 1922, pp. 404-405, 4 figs. Account of experiments made by author to determine loss of kinetic energy in jet due to varying deviation, and friction losses in bends. (Abstract.) Paper read before Melbourne Division of Instn. Engrs., Australia.

Pipe Efficiency. Pipe Friction and Pump Efficiency, William Brazenall. Colliery Guardian, vol. 123, no. 3191, Feb. 24, 1922, pp. 472-473. Results of experiments carried out with turbine, three-throw ram, and differential ram pumps. (Abstract.) Paper read before Min. Inst. of Scotland.

PUMPS, CENTRIFUGAL

Types and Operation. Centrifugal Pumps, J. W. Rogers. Eng. Rev., vol. 35, nos. 8 and 9, Feb. and Mar. 1922, pp. 259-262 and 296-301, 12 figs. Feb.: Advantages, principles, operating characteristics, efficiency and regulation, power requirement, electric motors. Mar.: Describes some modern types.

PYROMETERS

Ardometer and Holborn-Kurlbaum. The Measurement of High Temperatures with the Ardometer and the Holborn-Kurlbaum Pyrometer (Die Messung hoher Temperaturen mit Ardometer und Holborn-Kurlbaum-Pyrometer), Georg Keinath. Metall-Technik, vol. 47, no. 20, Dec. 15, 1921, pp. 161-164 and vol. 48, no. 1, Jan. 1, 1922, pp. 1-3, 9 figs. Describes the Holborn-Kurlbaum optical pyrometer, and the ardometer which is based on the Féry total-radiation pyrometer and said to possess excellent resistive qualities and great reliability.

R

RAILS

Head, Conditions Affecting. Conditions Affecting the Head of a Rail, James E. Howard. Eng. & Contracting, vol. 57, no. 11, Mar. 15, 1922, pp. 252-253. Review of destructive influences. Paper presented before N. Y. R. R. Club.

RAILWAY CONSTRUCTION

Specifications. American Railway Engineering Convention. Eng. News-Rec., vol. 88, no. 12, Mar. 23, 1922, pp. 498-501, 1 fig. Rail committee presents experimental rail specification based on quiet-seeting steel. Engineers and labor economics. Analysis of warehouse and freighthouse design. Specifications for movable bridges adopted.

RAILWAY ELECTRIFICATION

Economies Due to. The Future of Railroading is Electrification, W. R. Stemmetz. Can. Ry. Club Official Proc., vol. 20, no. 8, Nov. 8, 1921, pp. 16-39 (includes discussion). Discusses electrification generally in various countries, and enumerates economies due to it.

Holland. Electrification of Railways in Holland (Electrificatie van de spoorwegen in Nederland), J. J. W. Van Loenen Martinet. Ingenieur, vol. 37, no. 9, Mar. 4, 1922, pp. 151-162, 8 figs. Discusses report of commission appointed to study the question, which is review of electrification practice in various countries; also Amsterdam-Rotterdam electrification.

Induction Interference and Electrolysis. Effects of Electric Power Used for Traction, Chas. F. Scott. Ry. Age, vol. 72, no. 11, Mar. 18, 1922, pp. 727-729, 1 fig. Inductive interference and electrolysis as related to railroad electrification.

Superpower Survey. Superpower Survey, Gen. Elec. Rev., vol. 25, no. 2, Feb. 1922, pp. 72-94, 15 figs. Articles on The Superpower System as an Answer to a National Power Policy, by W. S. Murray; What the Superpower Survey Means to the United States, by H. Goodwin, Jr.; and Abstract of "Appendix C" of Superpower Report on the Electrification of Railroads, by W. D. Bearce.

RAILWAY MOTOR CARS

Gasoline. Gasoline Motor Cars for Railways (Motor-Benzol-Triebwagen für Eisenbahnen). Verkehrstechnik, vol. 39, no. 11, Mar. 17, 1922, pp. 130-131, 1 fig. Describes new cars with four-cycle engine built by the Kiel Dockyards of the German Works Corp., with 2 or 4 axles, weighing 9 and 15 tons, and having accommodation for 42 and 95 passengers, respectively.

Gasoline Motor Cars with Four-Wheel Drive. Ry. Age, vol. 72, no. 11, Mar. 18, 1922, 749-750, 4 figs. For passenger, freight and light switching; manufactured by Four-Wheel Drive Auto Co., Clintonville, Wis.; has three speeds; four-cylinder engine; 42 hp. by S.A.E. rules, but develops 68 hp. on a brake test.

New Haven Branch Lines. Motor Cars Used on New Haven Branch Lines. Ry. Mech. Engr., vol. 96, no. 3, Mar. 1922, pp. 139-141, 3 figs. Describes the Mack rail car used in local passenger service. Important advantages are flexibility and low-operating cost.

RAILWAY OPERATION

Automatic Train Control. American Train Control System. Ry. Signal Engr., vol. 15, no. 3, Mar. 1922, pp. 101-104, 6 figs. Detailed description of intermittent contact or ramp type system, developed by Am. Train Control Co. On right side of track ramps are arranged to apply brakes, on left side ramps are arranged to give only cautionary indication in cab.

Automatic Train Control System of General Railway Signal Co. Ry. Rev., vol. 70, no. 10, Mar. 11, 1922, pp. 339-347, 14 figs. Describes operation and advantages claimed.

G. R. S. Company's Auto-Manual Train Control. Ry. Elec. Engr., vol. 13, no. 3, Mar. 1922, pp. 95-97, 6 figs. Recent improvements by General Ry. Signal Co. of Rochester, in their automatic train-control system. Essential element of this system is arrangement for permitting engineman to cut out automatic brake-setting machinery and keep in his own hands full control of train; hence the name auto-manual train control.

Recent Tests of Train Stops and Control. Ry. Elec. Engr., vol. 13, no. 2, Feb. 1922, pp. 67-70, 5 figs. Describes Webb automatic train stop, and the M-V. All Weather train control, and tests carried out with them.

The Bourdette-Brookins Train Control System. Ry. Rev., vol. 70, no. 10, Mar. 11, 1922, pp. 353-355, 7 figs. System featuring three-position mechanically held plunger, to provide clear, caution and stop indications.

The Hearing on Train Control. Ry. Rev., vol. 70, nos. 12 and 13, Mar. 25 and Apr. 1, 1922, pp. 421-424 and 455-460. Gives summary of argument of 40 American railroads represented by Am. Ry. Assn. against recent order of Interstate Commerce Commission requiring installation of automatic train control.

The Regan Automatic Train Control Systems. Ry. Rev., vol. 70, no. 10, Mar. 11, 1922, pp. 347-344, 9 figs. Intermittent contact type, consisting of two elements, one comprising locomotive and tender equipment and other apparatus located on roadside. See also Ry. Signal Engr., vol. 15, no. 3, Mar. 1922, pp. 116-120, 8 figs.

The Simplex Train Control System. Ry. Rev., vol. 70, no. 10, Mar. 11, 1922, pp. 351-353, 3 figs. Works on principle of telegraphing track conditions to engine which is automatically controlled by device that applies air brakes.

The Union Switch & Signal Company's Automatic Train Control System. Ry. Rev., vol. 70, no. 10, Mar. 11, 1922, pp. 348-350, 6 figs. Describes company's complete speed-control system used as automatic-stop system.

Motive-Power Maintenance. Notes on the Maintenance and Supply of Motive Power in a Railway District, W. Land and H. B. Buckle. Ry. Gaz., vol. 36, nos. 2, 3, 4, 5 and 6, Jan. 13, 20, 27, Feb. 3 and 10, 1922, pp. 54-56, 97-100, 133-137, 170-173 and 212-215, 25 figs. Discusses maintenance and supply of power and its utilization as two interdependent questions which must be considered concurrently, and their supervision should be under one responsible command. Jan. 13: Running repairs; cleaning of engines. Jan. 20: Washing out of boilers; tube sweeping. Jan. 27: Sheer legs; electric wheel drops. Feb. 3: Preparing engine for work; mechanical handling of firebox ashes, method of dealing with engines in locomotive yard; breakdowns. Feb. 10: Distribution of locomotives for passenger and freight train arrangements in a given district.

Tonnage Rating. Practical Points on Dynamometer Car Tonnage Tests, O. O. Carr. Ry. Rev., vol. 70, no. 13, Apr. 1, 1922, pp. 451-455. Observations on Illinois Central show inaccuracy of office ratings and false economy of reducing tonnage to increase train speed.

RAILWAY SHOPS

Welding Practice. Standards of Railroad Shop Welding Practice, G. M. Calmbach. Ry. Elec. Engr., vol. 13, no. 2, Feb. 1922, pp. 51-56, 18 figs. Typical examples of boiler welding practice and general rules.

RAILWAY SIGNALING

Audible Signal. The Federal Signal Company's Audible Signal. Ry. Elec. Engr., vol. 13, no. 3, Mar. 1922, pp. 97-98, 1 fig. Describes experiments on Boston & Albany in Massachusetts and New York.

Missouri, Kansas & Texas Installations. The M. K. & T. Signaling Program. Ry. Signal Engr., vol. 15, no. 3, Mar. 1922, pp. 93-95, 10 figs. Describes installation with new ideas in pole-line construction, trunking and battery housing, of Missouri Kansas & Texas.

RAILWAY TIES

Life. A Means of Determining the Average Life of Ties, V. K. Hendricks. Ry. Age, vol. 72, no. 12, Mar. 25, 1922, pp. 779-783, 2 figs. Explanation of fluctuations in requirements on new lines and method of anticipating them.

Renewal Cost Calculation. Diagram for Calculating Annual Cost of Cross Ties, E. R. Cary. Eng. & Contracting, vol. 57, no. 11, Mar. 15, 1922, pp. 245-246, 2 figs. Describes method of making nomograph or alignment diagram.

RAILWAY TRACK

Curves. Railway Curves: Superelevation and Main-

tenance, E. E. R. Tratman. Eng. News-Rec., vol. 88, nos. 11 and 12, Mar. 16 and 23, 1922, pp. 446–449 and 489–492, 2 figs. Shows variations in practice and opinion. Influence of modern locomotives; relations of curvature to gage and grades; checking and marking.

RAILWAYS

Alaska. Completing the Government Railroad in Alaska. Ry. Age, vol. 72, no. 13, April 1, 1922, pp. 813–817, 8 figs. Describes Alaska railroad opened between Seward, on Resurrection Bay, and Fairbanks, in interior, on Feb. 5, 1922, a distance of 467 miles.

REFRIGERATING MACHINES

Compression. The Compression Refrigerating Machine, Gardner T. Voorhees. Ice & Refrigeration, vol. 62, no. 3, Mar. 1922, pp. 223–226, 1 fig. Study of floating heat question and clearance effect. (Continuation of serial.)

REFRIGERATION

Brine Spray. Brine Spray Refrigeration, S. C. Bloom. A.S.R.E. Jl., vol. 8, no. 4, Jan. 1922, pp. 308–321 (includes discussion) 10 figs. Describes experiments carried out with Webster nozzles and overhead spray systems.

RESEARCH

Industrial. A Plan for the Development of Industrial Research in Canada, S. F. Ruttan. Honorary Advisory Council for Sci. & Indus. Research, Dominion of Can., Bul. no. 10, 1921, 8 pp. (Abstract.) Address before Chem. Congress, New York.

RIVETS

Manufacture and Types. Riveting (Etude sur le rivetage). Ouvrier Moderne, vol. 4, no. 11, Feb. 1922, pp. 443–447, 12 figs. Metal used; manufacture of rivets; standard types of rivets; etc.

ROLLING MILLS

Drives. Factors which Influence the Size of Rolling-Mill Drives, L. Rothera. Iron & Coal Trades Rev., vol. 104, no. 2818, Mar. 3, 1922, pp. 306–308, 8 figs. Choice of sections to be rolled; output required; methods of rolling; drafting of rolls; number of passes taken. From English Elec. Jl.

Equipment. Adds New Rolling-Mill Equipment, Joseph Horton. Iron Trade Rev., vol. 70, no. 11, Mar. 16, 1922, pp. 746–748, 4 figs. Modern machinery installed in plants of Wm. Beardmore & Co., Ltd., Glasgow, Scotland, in transforming plant from war to peace-time production.

Friction Drive. A Friction Drive for Rolling Mills. Engineering, vol. 133, no. 3453, Mar. 3, 1922, p. 247, 3 figs. Describes new patented form of driving arrangement making use of friction rollers instead of ordinary gearing between engine and mill.

Sheet-Steel Rolling. The Possibility of Improved Methods of Rolling Sheet Steel, Summer B. Ely. Blast Furnace & Steel Plant, vol. 10, no. 3, Mar. 1922, pp. 175–178. Author does not think that a continuous sheet mill is impossible; believes extensive scientific experiments on the problem should be conducted. (Abstract.) Paper read before Engrs.' Soc. Western, Pa.

ROPE DRIVE

Continuous and Multiple Systems. Power Transmission by Ropes. Eng. & Indus. Management, vol. 7, no. 10, Mar. 23, 1922, pp. 287–289, 3 figs. Questions of cost and efficiency construction of rope pulley drives; relative merits of continuous and multiple systems.

S

SAFETY

Organization in Industrial Plant. Safety Organization, Harry A. Schultz. Safety, vol. 9, no. 3, Mar. 1922, pp. 56–74, 8 figs. Discusses in detail safety organization of an industrial plant, duties of safety committees and safety engineers, educational activities, first aid and rescue, etc.

SAND, MOLDING

Handling Equipment. Solving Sand Problem in a Steel Foundry, Edwin F. Cone. Iron Age, vol. 109, no. 15, Apr. 13, 1922, pp. 985–988, 6 figs. Mechanical equipment shakes out castings and prepares old and new sand with minimum of labor. Other features.

Uses and Abuses. Uses and Abuses of Molding Sands, Eugene W. Smith. Iron Age, vol. 109, no. 13, Mar. 30, 1922, pp. 860–861. Typical American sands and their composition; sand for various metals. Discussion. Paper read before Chicago Foundrymen's Club.

SCHOOLS, TECHNICAL

Ottawa. Wide Range of Instruction is Being Given, W. W. Nichol. Can. Machy., vol. 27, no. 11, Mar. 16, 1922, pp. 48–49, 4 figs. Activities of Ottawa Technical School, and its equipment. Subjects cover machine-shop practice, automobile mechanics, welding and cutting, structural and mechanical drafting, etc.

Toronto. This School Shows Remarkable Progress. Can. Machy., vol. 27, no. 11, Mar. 16, 1922, pp. 35–39, 8 figs. Describes the Technical High School, Toronto, and its facilities and equipment.

SCIENTIFIC MANAGEMENT

See INDUSTRIAL MANAGEMENT.

SCREW MACHINES

Automatic. 2-In. Automatic Screw Machine. Engineering, vol. 113, no. 2932, Mar. 10, 1922, pp. 286–290, 12 figs. Details of machine constructed by Brown & Sharpe Mfg. Co., Providence, L. I. Largest size stock it will work is $2^3/_8$ in. in diam., turning any up to 5 in. and feeding any length up to 6 in. It turns out from 3 to 180 pieces per hr.

Set-Up Instructions for Automatic. Set-Up Instructions for Brown & Sharpe Automatics, Samuel R. Gerber. Machy. (N. Y.), vol. 28, no. 8, Apr. 1922, p. 607. Gives list of setting-up operations for automatic screw machines and detailed explanation of operations.

SCREW THREADS

Comparator. Screw-Thread Measuring Comparators (Gewinde-Messkomparator), C. Büttner. Betrieb, vol. 4, no. 9, Feb. 11, 1922, pp. 289–292, 11 figs. Describes construction and function of a new optical screw-thread measuring machine for maximum accuracy, with which all dimensions can be determined in coefficients of measure.

Cutting Tools. Influence of the Automotive Industry on Thread-Cutting Tools, C. N. Kirkpatrick and G. G. Vink. Am. Mach., vol. 56, no. 13, Mar. 30, 1922, pp. 479–481, 5 figs. Development of interchangeability in automobile industry. Changes in methods of manufacturing threading tools. Design of Landis die head.

SEAPLANES

Lift and Drag. Full Scale Determination of the Lift and Drag of a Seaplane, Max M. Munk. Nat. Advisory Committee for Aeronautics Technical Notes, no. 92, Apr. 1922, 5 pp., 1 fig. Speed, barometric pressure, and number of revolutions of engine were measured, including tests with stopped engine. Results of gliding tests are used for computation of lift and drag coefficients, and by making use of them, results of engine flights are used for computation of propeller efficiency.

SHAFTS

Torsional Vibration. Torsional Vibrations in Shafts and the Nazzaro Damper (Le vibrazioni torsionali negli alberi delle distribuzioni e lo smorzatore "Nazzaro"), Pasquale Borracci. Industria, vol. 36, no. 2, Jan. 31, 1922, pp. 26–28, 5 figs. Explains origin of torsional vibrations and describes the Nazzaro device for controlling them.

SHERARDIZING

Experiments. Experiments With Sherardizing, Leon McCulloch. Metal Industry (N. Y.), vol. 20, no. 3, Mar. 1922, pp. 97–98. Formation of coating, with special reference to amount and effect of iron in coating.

SLOTTING MACHINES

Production Work on. Production Work on Slotting Machines. Machy. (Lond.), vol. 19, no. 492, Mar. 2, 1922, pp. 657–659, 6 figs. Operations advantageously performed on slotting machines or shapers of vertical type.

SMOKE ABATEMENT

Problems. The Smoke Problem, O. P. Hood. U. S. Bur. of Mines Reports of Investigations, serial no. 2323, Feb. 1922, 5 pp. Brief summary of problems. Smoke problem in England, and list of publications of Bur. of Mines dealing with problem.

SOOT BLOWERS

Steam Saving with. Steam Saving with Soot Blowers, Robert June. Textile World, vol. 41, no. 13, Apr. 1, 1922, pp. 75–76, 4 figs. Charts showing economy of improved equipment and extent of loss from excessive blowing.

SPECIFIC HEAT

Air, Steam and CO_2. The Specific Heats of Air, Steam and Carbon Dioxide, W. D. Womersley. Roy. Soc. Proc., vol. 100, no. A 706, Feb. 1, 1922, pp. 483–498, 10 figs. Describes experiments with improved Hopkinson calorimeter and gives results of hydrogen-air and carbon-monoxide experiments.

STACKS

Venturi. Venturi Stacks, A. W. H. Griepe. Combustion, vol. 6, no. 4, Apr. 1922, pp. 166–175, 18 figs. Describes Venturi-Evase-Prat-Stacks and their functioning, advantages and disadvantages, and compares different systems.

STANDARDIZATION

Norway. Standardization in Norway (Standardiseringsspörsmaalet i Norge). Teknisk Ukeblad, vol. 69, no. 8, Feb. 24, 1922, pp. 69–73. Report of committee to Norwegian Society of Industrials giving review of standardization work in countries abroad.

Progress. Progress in Engineering Standardization, C. W. Ham. Am. Mach., vol. 56, no. 13, Mar. 30, 1922, pp. 465–466. Advantages of simplified designs and adoption of uniform methods. Shop operation simplified, number of jigs reduced, stocking of parts in large quantities becomes possible. Work of American Engineering Standards Committee in establishing national and international standards.

Society Automotive Engrs. Work of. S.A.E.'s Recent Standardization Work. Automotive Industries, vol. 46, no. 14, Apr. 6, 1922, pp. 768–770, 2 figs. Revision in ball-bearing standards; Bessemer steel and wire spring stock; distributor, magneto and bumper mountings; motor-boat controls; passenger-car frames.

STEAM ENGINES

Back Pressure, Reducing. Using Exhaust Velocity To Reduce Back Pressure in Steam Engine. Power, vol. 55, no. 14, Apr. 4, 1922, p. 542, 3 figs. Prof. Stumpf and his associates, in designing a uniflow locomotive, have been able, by modification of exhaust ports and piping, to reduce back pressure on cylinder.

STEAM GENERATORS

Efficient. Modern Steam Generators for the Efficient Utilisation of Gaseous Fuels and the Efficient Recovery of Waste Heat, P. St. G. Kirke. West of Scotland Iron & Steel Inst. Jl., vol. 29, Part 3, Dec., Session 1921–1922, pp. 28–34 and (discussion) 34–36, 9 figs. on supp. plates. Discusses boiler development, including the Hopwood, Spencer-Hopwood, Bonecourt, Kirke and other types.

STEAM POWER PLANTS

Fuel Conservation. Fuel Conservation in Industrial Power Plants, David Moffat Myers. Gen. Elec. Rev., vol. 25, no. 2, Feb. 1922, pp. 95–98. Effecting economies in steam plants by proper equipment of recording instruments selected to suit local conditions.

Heat Balance and Steam Distribution. Heat Balance and Steam Distribution in a Large Service Plant, S. D. Kutner. Power, vol. 55, no. 13, Mar. 28, 1922, pp. 488–491, 1 fig. Tells how steam, hot water and power are charged to different departments in large building supplied from an isolated power plant.

STEAM TURBINES

Modern Installation. A Modern Steam-Turbine Installation in Spitzbergen (Eine moderne Dampfturbinen-Anlage auf Spitzbergen), A. C. Gogstad. Schweizerische Bauzeitung, vol. 79, no. 12, Mar. 25, 1922, pp. 149–151, 4 figs. Describes central station and equipment delivered by Oerlikon Machine Works, Switzerland.

STEEL

Alloy. See ALLOY STEELS.

Chrome. See CHROME STEEL.

Stainless, Cutlery of. Making Stainless Steel Cutlery, R. G. Hall. Iron Trade Rev., vol. 70, no. 13, Mar. 30, 1922, pp. 896–897. Carbon content of 0.30 to 0.45 per cent and chromium 13 to 15 per cent is recommended. Roll scale must be eliminated and working tools kept sharp to prevent cause for oxidation. Stainless tests. See also (abstract) in Iron Age, vol. 109, no. 13, Mar. 30, 1922, pp. 855–856.

Structural. See STRUCTURAL STEEL.

STEEL CASTINGS

Economical Production. Steel Casting Plant Has Liaison Service, G. P. Blackiston. Iron Age, vol. 109, no. 14, Apr. 6, 1922, pp. 925–927, 5 figs. How Detroit Steel Casting Co. cooperates with its customers in designing parts for effective production and decrease of waste.

STEEL, HEAT TREATMENT OF

Structural Parts. Heat Treating Steel For Structural Parts, Horace C. Knerr. Blast Furnace & Steel Plant, vol. 10, no. 3, Mar. 1922, pp. 178–183, 10 figs., Means of estimating carbon content from microstructure after annealing; comparison of effects of heat treatment on various steels from mild to tool steel.

Principles. Theory of the Heat Treatment of Steel, Walter M. Mitchell. Forging & Heat Treating, vol. 8, nos. 1, 2 and 3, Jan., Feb. and Mar. 1922, pp. 52–56, 114–118 and 162–166, 20 figs. Jan.: Critical temperatures; constitution of slowly cooling steel. Feb.: Constituents of suddenly cooled steels; practice in heat treatment. Mar.: Discusses hardening and tempering and deduces schedule of heat treatment.

STEEL MANUFACTURE

Basset Process. Steel Direct from Ore by Basset Process, Fritz Wuest. Iron Age, vol. 109, no. 15, Apr. 13, 1922, pp. 989–991, 2 figs. Its chief features and advantages. Critical discussion of claims for French process by German engineer. Cost of plant. Translated from Stahl u. Eisen, Dec. 22, 1921.

High-Speed and Tungsten. Notes on the Manufacture of High-Speed and Tungsten Steels, J. W. Weitzenkorn. Chem. & Met. Eng., vol. 26, no. 11, Mar. 15, 1922, pp. 504–508, 14 figs. Steps taken in studying segregation in high-speed and tungsten steel. Structural disposition of carbides after various heat treatments, with or without previous mechanical work.

Losses, Reducing. Reducing Losses in Steelmaking, F. G. Cutler. Iron Trade Rev., vol. 70, no. 15, Apr. 13, 1922, pp. 1040–1042, 2 figs. Method of comparing total combustion efficiency of iron and steel plant from time to time is proposed. Economic use of blast-furnace and coke-oven gas. (Abstract.) Paper to be presented before Am.Soc.Mech.Engrs.

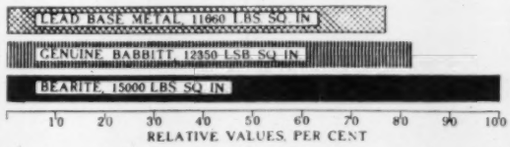
STEEL WORKS

Calcutta, India. New Plant of the Indian Iron and Steel Company, Limited. Iron & Coal Trades Rev., vol. 104, no. 2815, Feb. 10, 1922, p. 198, 3 figs. Describes design and equipment.

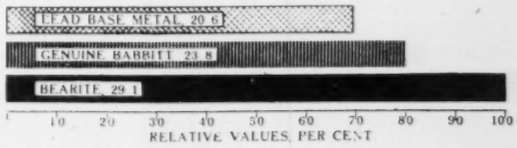
Electric Power in. The Application of Electric Power in the Iron and Steel Industry, W. S. Hall. Iron & Steel Elec. Engrs. Assn., vol. 4, no. 3, Mar. 1922, pp. 127–140 and (discussion) pp. 140–151. Brief analysis of sources of waste fuel in iron and steel manufacture; determining whether expenditure for recovering waste fuel is desirable. Problems of power generation and transmission.

Power-Plant Management. Steel Works Power Plant Management, Robert June. Blast Furnace & Steel Plant, vol. 10, no. 3, Mar. 1922, pp. 197–201, 3 figs. Fixed charges and maintenance; manner of figuring depreciation of power-house equipment.

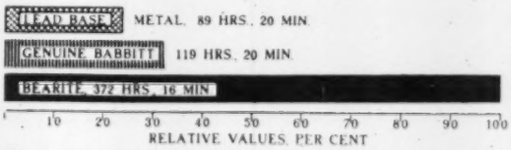
THE RELATIVE PHYSICAL PROPERTIES OF BEARITE, GENUINE BABBITT AND TYPICAL LEAD BASE METAL


LEAD BASE METAL 11660 LBS SQ IN
GENUINE BABBITT 12350 LSB SQ IN
BEARITE 15000 LBS SQ IN
10 20 30 40 50 60 70 80 90 100
RELATIVE VALUES PER CENT

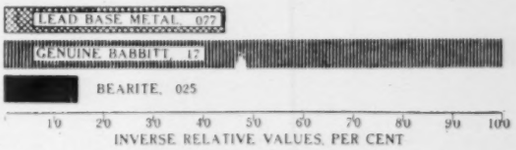
COMPRESSIVE STRENGTH: showing pressure required to reduce the test pieces 1 per cent of their original height.



BRINELL HARDNESS: indicating, not only the hardness, but the relative tenacity of the metals.


LEAD BASE METAL 89 HRS 20 MIN
GENUINE BABBITT 119 HRS 20 MIN
BEARITE 372 HRS 16 MIN
10 20 30 40 50 60 70 80 90 100
RELATIVE VALUES PER CENT

RELATIVE LIFE: the average time required to remove 1 gram of metal, with water lubrication, under varying loads and speeds.



COEFFICIENT OF FRICTION: showing the average coefficient, with water lubrication, under varying loads and speeds.

A Chart that Made History

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Engineering Bulletin M-1 is the Bearing Metal Handbook for 1922.

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